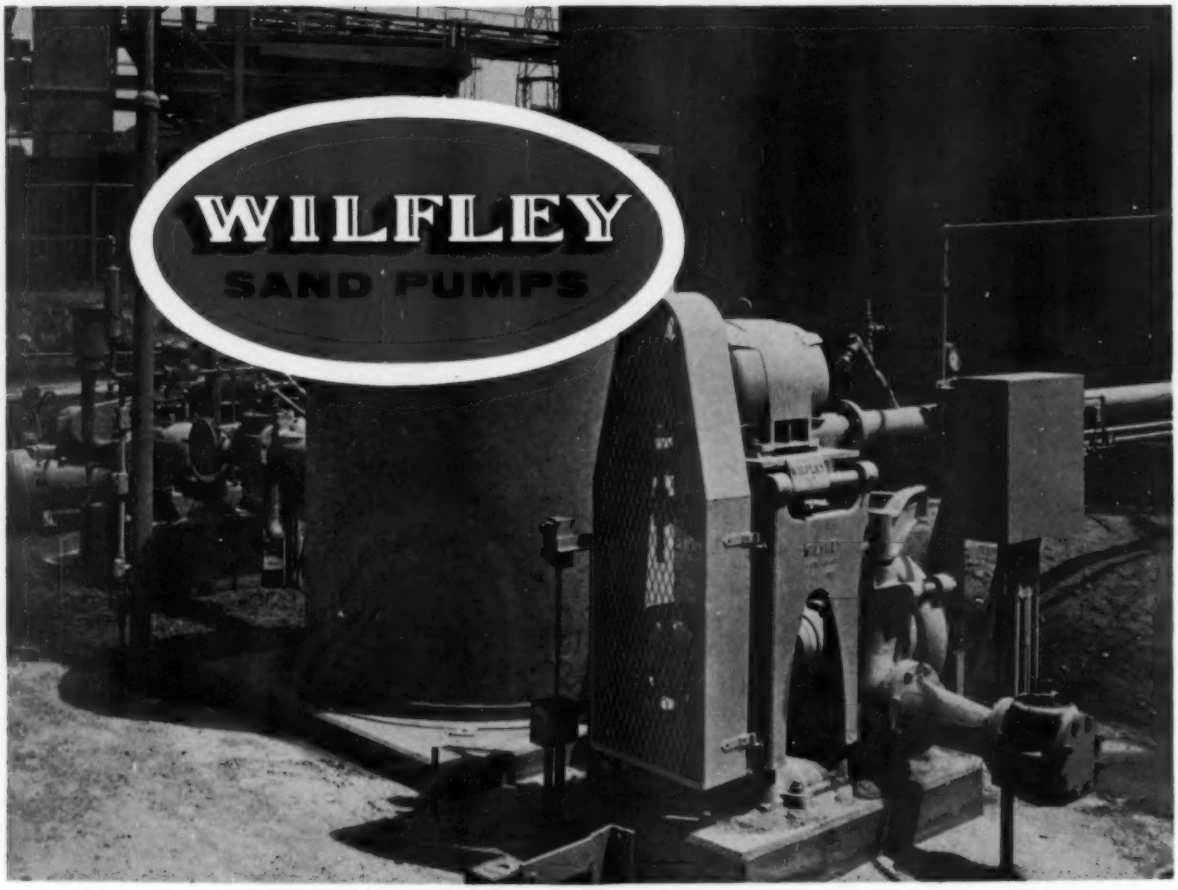
MINING engineering

MARCH 1961



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COMING EVENTS

Mar. 20-22, CIM Annual Meeting, Chateau Frontenac, Quebec.
Please note: The April date listed in this column in February was **incorrect.**

Mar. 30-Apr. 1, Fourth Symposium on Rock Mechanics, sponsored by mining departments of Colorado School of Mines, University of Minnesota, Missouri School of Mines and Metallurgy, and The Pennsylvania State University. The Pennsylvania State University, University Park, Pa.

Apr. 4-7, Short Course on computers and application for managerial and technical personnel in minerals industries. University of Arizona. Address E. R. Drevdahl, College of Mines, University of Arizona, Tucson, Ariz.

Apr. 9-11, Society of Exploration Geophysicists 14th Annual Midwestern Meeting, Skirvin Hotel, Oklahoma City, Okla.

Apr. 10-12, 44th National Open Hearth Steel Conference and Blast Furnace, Coke Oven, and Raw Materials Conference, Sheraton Hotel, Philadelphia.

Apr. 13-14, Conference on use of radioisotopes in mining industry, Brown Palace and Cosmopolitan hotels, Denver. Sponsored by Amer. Mining Cong. and Colorado School of Mines Research Foundation in cooperation with AEC.

Apr. 12-14, International Symposium on Agglomeration, sponsored by SME, SPE, and TMS of AIME, Sheraton Hotel, Philadelphia.

Apr. 20-22, 76th Annual Convention, Illinois Society of Professional Engineers, Peoria, Ill.

Apr. 22, Annual Spring Technical meeting of the Upper Peninsula Section AIME, Civil-Geology Bldg., Michigan College of Mining and Technology, Houghton, Mich.

Apr. 23-26, ASME Metals Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

Apr. 24-25, AIME Southwest Minerals Industry Conference, sponsored by SME Industrial Minerals Division and AIME Nevada Section. Stardust Hotel, Las Vegas, Nev.

Apr. 26-27, AIME Technical Conference on High-Temperature Materials, Carter Hotel, Cleveland.

May 13-14, Sixth Annual Uranium Symposium, sponsored by AIME Central New Mexico Section. Grants, N. M.

May 15-18, Coal Show of the American Mining Congress, Cleveland. Suggestions for topics to be included in program should be sent to American Mining Congress, Ring Bldg., Washington 6, D. C.

May 17-19, First Conference on Management of Materials Research, sponsored by The Metallurgical Society of AIME. Arden House, Harriman, N. Y.

May 20, AIME Colorado MBD Subsection annual meeting with technical papers, Broadmoor Hotel, Colorado Springs, Colo.

May 25-26, 37th Annual Conference, Lake Superior Mines Safety Council, Hotel Duluth, Duluth, Minn.

June 6-8, Sixth Annual Appalachian Underground Corrosion Short Course, West Virginia University School of Mines, Morgantown, W. Va. For information write John H. Alm, Publicity Chairman, Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.

June 6-8, National Coal Assn., 44th Annual Meeting, Mayflower Hotel and Coal Bldg., Washington, D. C.

Sept. 11-14, American Mining Congress Metal Mining—Industrial Minerals Convention, Seattle, Wash.

Sept. 17-20, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Minerals Beneficiation Division, Brown Palace and Cosmopolitan Hotels, Denver.

Oct. 2-3, Joint Meeting, Industrial Minerals Division of SME of AIME—CIM, Ottawa.

Oct. 5-7, AIME-ASME Joint Solid Fuels Conference, Birmingham.

MINING engineering

VOL. 13 NO. 3 **MARCH 1961**

COVER *The portrait of James C. Gray, 1961 President of the Society of Mining Engineers, by artist Herb McClure, continues the custom of MINING ENGINEERING in so honoring each new leader of the Society. His message to all members of SME will be found on page 253.*

ARTICLES

255 **Use of Pressure Grouting to Stabilize Ground in the San Manuel Mine** • *J. W. Goss and M. J. Coolbaugh*

262 **Mechanized Tamping of Mine Haulage Roads** • *D. H. Davis*

264 **The Role of the Geologist at Butte** • *E. P. Shea*

269 **Economic Justification for Froth Flotation of Coal** • *J. W. Miller*

274 **Hydraulic Transportation of Florida Phosphate Matrix**

Introduction • *H. B. Hardy and S. A. Canaritis*

Achan and Noralyn Mines • *M. T. Smith*

Sydney Mine • *U. K. Custred*

Tenoroc Mine • *J. L. Wester*

282 **Measurement of Rock Pressure with a Hydraulic Cell** • *L. A. Panek*

PLUS

272 **Gouverneur Talc Co.'s Dry Blending Method for Finely Ground Materials** • *R. S. McClellan*

286 **TV at TCI**

DEPARTMENTS

226 **Personnel**
228 **Mineral Information Section**
231 **Manufacturers News**
233 **Free Literature**
237 **Reporter**
246 **SME Preprint List**
253 **Drift: Our Role in a Challenging Decade** • *J. C. Gray*
287 **SME Bulletin Board**
294 **Around the Sections**
299 **Personals**
305 **Obituaries**
310 **Professional Services**
314 **Advertisers Index**

FEATURED ITEMS

228 **Mineral Information**
• *Books, Abstracts, Manufacturers News, Free Literature*

246 **SME Preprints Available from 1961 Annual Meeting**

253 **1961 SME President, J. C. Gray, States Views**

287 **Bulletin Board—Index for News of Society and Profession**

MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the *Drift* page.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical, Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number. When making application for a position include 8¢ in stamps for forwarding application. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., **New York 18;** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

MEN AVAILABLE

Operations Superintendent, mining engineer, age 37. Seven years experience, of which four and a half have been in highly mechanized open pit metal mining. Knowledge all phases from pre-mining drilling to shiploading. Any location. M-584.

Manager for mine or quarry, B.S. in mining engineering, age 51. Twenty-eight years all phases of open pit mining using truck, corregor or railroad haulage, heavy equipment, and big tonnages. Available immediately. Prefer U.S. M-2057-Chicago.

Field or Mining Engineer, B.S. in mining engineering, age 29. Twenty months photogrammetry field control, computations, party chief, planning; seven months field engineer bridge construction; three months underground western metal mines. Prefer U.S., will consider foreign. M-2058-Chicago.

Mine Manager or Superintendent, B.S. in mining engineering. Thirty-five years experience as engineer, workman supervisor, mine superintendent, and mine manager. Prefer Central America, U.S., or Mexico. M-586.

Geological Assistant, B.S. in geology (minor in mathematics and mining engineering). Two summers as surveyor's assistant, one summer detailed and reconnaissance geologic mapping for scientific research. West. M-587.

Geological and/or Mining Engineer, B.S. from Columbia University, '50. Eleven years geological and mining engineer; mine supervisor. Experienced in mineral exploration, geochemistry, geophysics, mine planning, and mine supervision. Age 34, married. Location open. M-588.

Manager, General Superintendent, age 49, married, American. World-wide experience in management and engineering; exploration, operation, and head office; metallic and nonmetallic minerals, manufacturing and construction. Prefer U.S., willing to travel. M-589.

Mining Engineer, graduate, age 30. Four years experience mine production and engineering; two years supervisory experience. Speak Spanish. Prefer foreign. M-590.

Geologist, M.S. geology, '51. Seven years mining and exploration geology U.S. and abroad in metals and nonmetals. Geochemical experience; one and one-half years professor and head of department. Fluent Spanish. Prefer temperate or tropical location. M-591.

Mine Geologist, B.Sc., M.Sc. in geology, age 34, British, married, no family. Five years varied experience overseas in exploration and development of open cast iron ore, alluvial and beach sands, underground and surface gold deposits. M-592.

Manager. Twelve years in inorganic chemistry, extractive metallurgy and minerals beneficiation of iron and uranium. Q-cleared, will relocate. M-593.

Vice President or Manager-Engineering or Operations, B.S.E.E., M.S.M.E. Directly responsible for major profit increases, broad administrative experience in operations, engineering, research and development; highly creative holder of many patents; exceptional ability to direct scientific and engineering personnel. Location immaterial. M-594.

Exploration Geologist, B.S. in geological engineer, '43. Seventeen years broad experience exploration geology and geophysics, both metals and petroleum. Management experience small oil company. U.S. or foreign. M-595.

Mine Superintendent and Engineer, B.S. in mining engineering, age 44. Mine superintendent, four and one-half years industrial minerals, underground open stoping. Assistant district engineer super highway construction; two years mining research engineer, deep mine coal. East, South, Midwest preferred. M-596.

Mining Engineer, 35, married, 2 children. Twelve years experience underground operation, plant design, labor negotiations. Desire challenging position, preferably South America. Speak fluent Spanish. Available one month's notice. M-597.

Economic Geologist, Ph.D. in geology, age 31. Seven years varied background in metals, nonmetals including petroleum and mineral economics. Experience in modern exploration, evaluation and research techniques used in studies of mineral deposits. Field work in U.S. and Canada. Desires responsible position with diversified organization, presently employed. Location open. M-2018-Chicago.

Production Supervisor-Mining Engineer, B.S. in mining engineering, age 29. Five years experience including supervision in mill, cost studies, exploration, surveying, underground experience (square set, cut and fill, and room and pillar). Prefer U.S. M-2077-Chicago.

(Continued on page 242)

RHOANGLO MINE SERVICES LIMITED, KITWE, NORTHERN RHODESIA

SENIOR MINERALOGIST • MINERALOGIST

Applications are invited from qualified mineralogists for posts in the Mineralogical Section of the Research and Development Division, Kitwe, which undertakes a wide range of projects in extraction metallurgy for the Rhodesian Companies of the Anglo American Corporation of South Africa, Limited. These vacancies are the result of promotions and expansion.

Facilities in the Mineralogical Section include X-Ray diffraction equipment, projection microscope and infrasizing and superpanning equipment as well as the usual microscopes, photographic facilities and sample preparation equipment. Analytical services are available.

Applicants for the post of Mineralogist should have had some experience in determinative mineralogy and in petrology. The Senior Mineralogist, who would report directly to the Assistant Superintendent of the Division, should have sound experience in the above fields and the ability to co-ordinate and supervise the work of a team of three mineralogists. He would also be required to liaise with geologists and research and plant personnel on mineralogical problems. A knowledge of mineral concentration techniques would be an advantage.

The commencing basic salaries for these positions will be determined by qualifications and experience but will not be less than:-

Senior Mineralogist	£1,587 (Stg) per annum
Mineralogist	£1,191 (Stg) per annum

In addition to the basic salary, both positions carry a bonus varying with the prosperity of the copper-mining industry (at present about 40% of basic salary) and a variable cost of living allowance (currently about £62 per annum). There are also generous pension, life assurance and medical benefits and a low rate of income tax. Air or sea passage for the successful candidates would be paid by the Company and, dependent upon the point of entry into the salary range, assistance would be provided towards importation expenses.

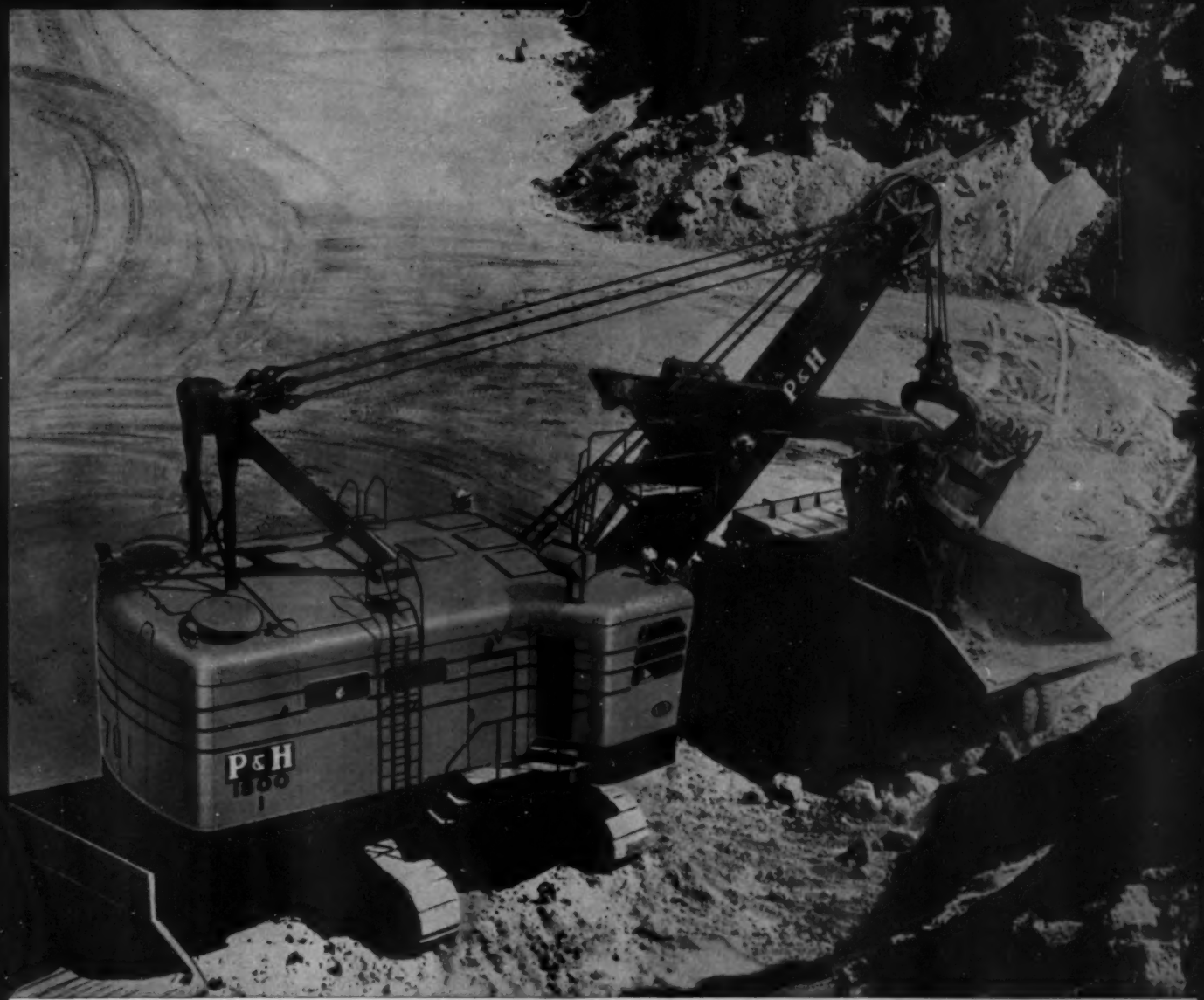
Kitwe in Northern Rhodesia is situated on the Central African Plateau at an altitude of 4,100 feet above sea level and consequently enjoys an equable healthy climate of dry winters with a rainy season moderating summer temperatures.

Ample all the year round facilities for all the usual sports are available and the generous leave allowance together with excellent rail, road and air communications permits long leaves to be spent at either various coastal resorts or abroad. Leave may be accumulated for up to three years and varies between 48 and 51 days per annum depending on salary.

Housing provided complete with basic furniture, refrigerator etc. is of excellent standard and provided with all modern amenities at a nominal rental and African domestic labour is readily available.

Replies, stating age, marital status, qualifications, experience record, and availability, together with names of two referees, and a recent photograph, should be addressed by airmail to:

The Secretaries, P. O. Box 172
Kitwe, Northern Rhodesia



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Minerals Yearbook 1959, USBM, Vol. I, Metals and Minerals (except Fuels), *U.S. Government Printing Office*, Superintendent of Documents, Washington 25, D. C., 1960, 1271 pp., $4.50—The new volume is the largest yet published, presenting statistical coverage of scores of minerals. It also introduces a new chapter on technologic trends in the mineral industries. Another new feature is an index listing references to important mining and mineral processing companies where they occur in the texts of the various chapters. • • •

Minerals Yearbook 1959, USBM, Vol. II, Fuels, *U.S. Government Printing Office*, Superintendent of Documents, Washington 25, D. C., 1960, 483 pp., $2.50—This volume contains two general review chapters and ten separate commodity chapters divided among coal and related products, petroleum and related products, and helium, which, though not a fuel, is grouped with them because it is found chiefly in natural gases. • • •

Minerals Yearbook 1959, USBM, Vol. III, Area Reports, *U.S. Government Printing Office*, Superintendent of Documents, Washington 25, D. C., 1960, 1134 pp., $4.00—This volume contains a detailed review of the mineral extractive industries in each of the 50 states and Puerto Rico. The chapter on Puerto Rico also includes references to the Panama Canal Zone and island possessions of the U.S. in the Atlantic and Pacific oceans. • • •

Fracture Systems and Tectonic Elements of the Colorado Plateau by Vincent C. Kelley and N. James Clinton, *University of New Mexico Press*, Albuquerque, N.M., 1960, 104 pp. and tectonic map, $2.75—A description and study of regional fracture systems in a 90,000-sq mile area of the Colorado Plateau and small adjacent strips of the Rocky Mountains but excluding most of the Uinta and Picenace basins and Grand Canyon section from the Kaibab uplift westward. Fracture systems are described under 35 tectonic divisions, with a brief sketch of the structural geology and rock types. The tectonic map of fracture patterns includes an index of anticlines, faults, and igneous centers.

Paleogeological Maps by A. I. Levorsen, *W. H. Freeman & Co.*, 660 Market St., San Francisco 4, Calif., 1960, 174 pp., $6—A paleogeological map of a surface of unconformity may be thought of as a flashback in the history of that area. This book demonstrates how these maps are prepared and explains the interpretations that may be made from them, as in determining the sequence of deformation, desposition, erosion, truncation, fluid flow, metamorphism, and location of wedge belts of rocks. Specific maps of oil fields and of special regional areas in the U.S., Canada, South America, England, and Europe, as well as of continental areas, are shown and discussed. • • •

Progress in Metallurgical Technology, published for the Institution of Metallurgists, Dorset House, Stamford St. by *Iliffe & Sons*, London 1960, 147 pp., approx. $4.60 (32s 6d)—This volume is comprised of four lectures delivered at the 13th annual refresher course of the Institution of Metallurgists, held in Scarborough in 1959. The papers cover modern developments in iron and steel production, extrusion and refining of nonferrous metals, and melting and casting of both ferrous and nonferrous metals.

The Canadian Mineral Industry, 1957, Mineral Report 2, *Department of Mines and Technical Surveys*, Ottawa Ontario, Canada, 1960, 491 pp., $1.00—This is a statistical report of metallic minerals, industrial minerals, and mineral fuels produced and consumed in commercial quantities in Canada in 1957, including a general summary and individual treatment of all of the major minerals. Where pertinent or available, data includes exports, world production figures, and 1957 price ranges, as well as descriptions of mines and nonproducing mineral occurrences, metal uses, and ore specifications.

Crushing and Grinding: A Bibliography, *The Chemical Publishing Co. Inc.*, 212 5th Ave., New York 10, N.Y., 1960, 436 pp., $10.50—Every aspect of crushing and grinding operations in the mineral and chemical industries is covered in this volume, which is divided into two main sections. Part I consists of short reviews on the most important aspects of crushing and grinding. Part II, which makes up the bulk of the book, contains abstracts with annotations of 2800 articles and books published on this topic from 1920 to 1960. Included are such subjects as theoretical aspects, types of equipment used and their efficiency, particle size and surface area determination, coarse and fine reduction, materials, and industrial hazards and their elimination. • • •

Historical Statistics of Minerals in the U.S., compiled by Sam H. Schurr and Elizabeth K. Vogely, *Resources for the Future Inc.*, 1775 Massachusetts Ave. N.W., Washington, D.C., 1960, 48 pp., $1.00—This volume is a reprint of the minerals chapter of the Census Bureau's *Historical Statistics of the U.S.—Colonial Times to 1957*, published early in 1960. Supplemented by 18 pages of notes, the publication contains 22 tables including: Summary of Mineral Operations: 1840 to 1954; Value of Mineral Products, in Current Dollars: 1880 to 1956; Indexes of Physical Volume of Mineral Production (Bureau of Mines): 1880 to 1956; Nonmetals: 1818 to 1956; Copper: 1845 to 1956; Gold and Silver: 1792 to 1956; and Injuries and Fatalities in Coal Mining, Quarrying and Related Industries, and Metal and Nonmetal Mines: 1870 to 1956.

FBI Register of British Manufacturers, 1961, 33rd edition, published for the Federation of British Industries by Kelly's Directories Ltd. and *Iliffe & Sons Ltd.*, Dorset House, Stamford St., London S.E. 1, England, 1960, 1162 pp., approx. $7 (50s)—A comprehensive and accurate guide to a substantial cross section of British industry, with lists of the products and services of nearly 8000 member firms under more than 5400 alphabetical headings. In addition to the Classified Buyers' Guide there are seven other sections in the Register, giving addresses of companies, valuable information about trade associations, proprietary names, trade marks, etc.

Canada

Government Publications

Queen's Printer
Ottawa, Ontario

Direct Iron Processes and Their Prospects in Eastern Canada, Mineral Information Bulletin MR41, 50¢, 1960.
Survey of the Canadian Iron Ore Industry during 1959, Mineral Information Bulletin MR45, 50¢, 1960.
Metal and Industrial Mineral Mines in Canada, Operators List 2, 25¢, 1959.
Milling Plants in Canada Metallic Ores, Operators List 3, Part 1, 25¢, 1959.
Ceramic Plants in Canada, Operators List 6, 25¢, 1959.
The Canadian Mineral Industry 1956, Mineral Report 1, $1, 1960.

British Columbia

Dept. of Mines and Petroleum Resources
Victoria, B.C.

Index to Published Geological Mapping in British Columbia, $2, 1960.

Manitoba

Dept. of Mines and Natural Resources
469 Broadway Ave.
Winnipeg 1, Canada

A Study of the Tow Lake Gabbro, Publication 53-5, gratis, 1958.
Geology of the Lynn Lake District with geological maps and sections in separate volume, Publication 57-1, $2 with maps, 1960.
Mississippian Stratigraphy of Manitoba, Publication 58-1, gratis, 1959.
Geology of the Oxford House-Knee Lake Area, Publication 58-3, gratis, 1959.

Newfoundland

Dept. of Mines and Resources
St. John's, Newfoundland

Gypsum in Newfoundland, Mineral Resources Report No. 1, 50¢, 1959.

Ontario

Dept. of Mines
Parliament Bldgs.
Toronto 2, Ont.

List of Publications Issued by the Ontario Dept. of Mines, Bulletin No. 25, gratis, 1960.
The Limestone Industries of Ontario, Industrial Minerals Circular No. 5, gratis, 1960.
General Index to the Annual Reports of the Ontario Dept. of Mines—1951 to 1955, $1, 1960.
Dr. John F. Paterson's Report on Silicosis in the Mining Industry, Bulletin 158, $1, 1959.

Quebec

Dept. of Mines
Hotel du Gouvernement
Quebec, Canada

Sample Preparation Techniques for X-Ray Fluorescence Analysis, Preliminary Report P.R. No. 402, gratis, 1960.
Southwest Quarter of Lévy Township, Electoral District of Abitibi-East, Preliminary Report P.R. No. 419, gratis, 1960.
Lorraine-Flandre Area, Pontiac Electoral District, Preliminary Report P.R. No. 420, gratis, 1960.
Rohault Area Abitibi-East and Roberval Electoral District, Geological Report 86, 1959.
Hazeur-Druillettes Area Abitibi-East Electoral District, Geological Report 87, 1959.
Outline of Progress of the Mining Industry in the Province of Quebec during the Year 1959, S 50, 1960.
Data on wells drilled for gas and petroleum in the St. Lawrence Lowlands area, S-49, 1960.
Location of wells drilled for oil and gas, St. Lawrence Lowlands, Map No. 1288, 1960.
Upper Deception River Area, New Quebec, P.R. 398, 1959.
Peppler Lake Area (East Half), Saguenay electoral district, P.R. 401, 1959.
Vermette Lake Area (East Half) Saguenay electoral district, P.R. 397, 1959.
Leaf Bay Area, New Quebec, P.R. 399, 1959.
Matawin-Mekinac Area, Lavioletie electoral district, P.R. 395, 1959.
Cross Lake Area, New Quebec, P.R. 396, 1959.
List of the Principal Operators and Owners of Mines and Quarries in the Province of Quebec, S-39, 1958 with 1960 supplement.

Inspection Branch

Dr. John F. Paterson's Report on Silicosis in the Mining Industry, Bulletin 158, $1, 1959.

(Continued on page 241)

For a first hand look at Lindberg's comprehensive line of semiconductor production equipment be sure to visit Lindberg's Booth No. 4043 at the New York IRE Show
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"Our new 944 Traxcavator loads and levels nine 18-yd. trucks an hour

It gets its bucket full easier than other machines, is faster and handles better. Has plenty of reach for big trucks, too."

THAT's the word on the 944 from Craig Childers, Western's Plant Superintendent. And here's what the operator thinks about it, "I like the way it handles. It's really a fast-loading machine; and it has good balance and visibility. The idea of having the lift arms out front where you don't sit between them is great."

You can choose from three sizes in the new Traxcavator line. The 944 packs 105 HP and a 2 cu. yd. standard bucket—the big 966 at 140 HP carries a 2¾ cu. yd. standard bucket—and the 80 HP 922 has a 1¼ yd. bucket. All three mount a variety of buckets and attachments for handling various materials. And all three have what it takes to move more tons per hour and stay on the job month after month with far less maintenance.

Your Caterpillar Dealer has all the facts. Ask him to set up a Traxcavator demonstration on your job, and get a firsthand look at all the new ideas that are built into these machines. It'll be a real eye-opener.

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TRAXCAVATORS ARE MAKING OTHER LOADERS OBSOLETE

Here's how the 922, 944 and 966 are built to do a better job for you.

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CAT POWER SHIFT TRANSMISSION—gives instant shifting, forward and reverse, 1st and 2nd speeds. High and low range selector also provides two-wheel drive for roading, four-wheel drive for power and traction in work cycles.

OPERATOR SAFETY—Lift arms and cylinders are forward of the operator and cockpit. Visibility is excellent and access is easy . . . up three wide steps.

LONG REACH—With the lift arms up front, the reach at dumping height of the new Traxcavators is impressive: 57" on the 966, 51" on the 944 and 41" on the 922.

OPERATOR CONVENIENCES—Bucket controls have automatic positioners to speed every cycle; machine controls are all power boosted for easy operation. Dual brakes give operator choice of braking with or without transmission engaged.

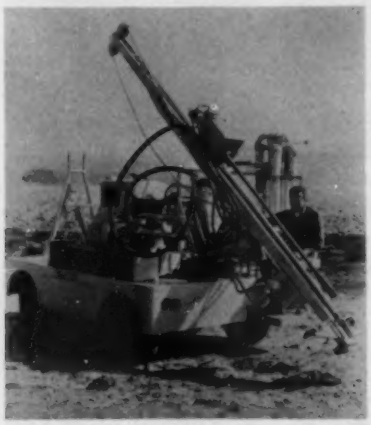
FULL LINE OF ATTACHMENTS—Special material buckets, side dump buckets, forks, cabs, etc.

MANUFACTURERS NEWS

NEWS / EQUIPMENT / CATALOGS

Self-Propelled Rotary Drill

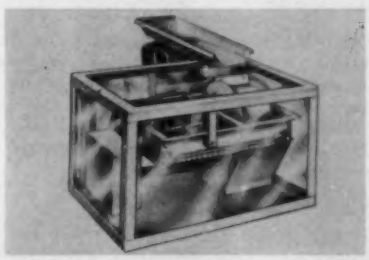
A one-man, self-propelled, hydraulically operated rotary drilling rig has been introduced by *Houston Tool Company*. It operates on a 30 hp, 4-cylinder, air-cooled engine with four forward speeds and one reverse. Carrying all of its own equipment



plus 250 ft of drill pipe, this unit also features a swing-away seat that affords excellent driving and drilling vision. Plastic tubes allow continuous examination of the stratum and make grab samples easy without interrupting drilling. This machine is capable of drilling 2⅜-in. to 3-in. diam hole to 250 ft. **Circle No. 1.**

Weigh Wheel

Syntron Company has developed a gravimetric feeder with a "weigh wheel" feature. It is designed for continuous weigh feeding of bulk materials. A vibratory feeder feeds the material onto a scale-beam-



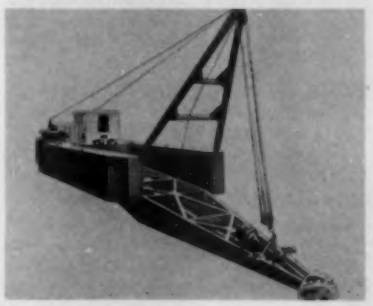
mounted, constant-speed wheel. When the poise has been set on the beam for the required rate, the over and under movements of the beam actuate the "weigh-stat" control. This automatically decreases or increases the feed rate of the vibratory feeder, compensating for more or less material on the weigh wheel. Five models with capacities from 500 lb to 300 tph are available. **Circle No. 2.**

Fabric-Backed Urethane Liner

Fabric-backed urethane, designed to be used as a liner for handling ore slurries, coal, coke, rock, sand and gravel, and other abrasive materials, has been developed by the *Armstrong Cork Co.* Called "Armstrong PO-663," this material provides maximum abrasion resistance, allows use of thinner gauge materials, reduces maintenance cost, and can be easily installed by cementing or bolting. PO-663 is available in standard stock sheet sizes ranging from 12x20 in. to 96x40 in., in 1/16, 1/8, and 1/4-in. gauges. **Circle No. 3.**

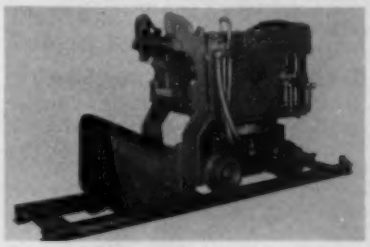
Portable Dredge

The "Hydra-Drive" portable sand and gravel dredge has been developed by *American Marine & Machinery Co., Inc.* Operators report production costs cut 20¢ to 30¢ per yard by eliminating handling operations, extra equipment, and manpower. This dredge has a specially designed ladder with a hydraulically-driven cutterhead which can dig at depths to 60 ft. These machines are available with pumping distances up to 3000 ft and capacities from 75 to 1500 tph. **Circle No. 4.**



Mine Car Loader

An advanced-design mine car loader has been introduced by the *Gardner-Denver Company*. Called the "GD18," it reportedly affords full utilization of power because its weight distribution and force leverages have been balanced with the highest horsepower available. This balanced design reportedly assures safety, speed, and ease of operation. **Circle No. 5.**



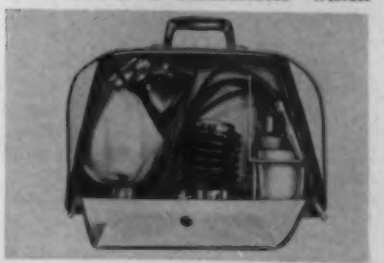
Sample Splitter

The "Porta Splitter," a portable sample splitter introduced by *Gilson Screen Co.*, halves and quarters ½-cu ft samples of material from sand up to 2-in. aggregate. Chief features: loading hopper that permits hand levelling of the sample to

be divided, and an adjustable universal splitter chute which provides quick and accurate selection of a variety of chute openings. The chute consists of a series of aluminum or plated steel bars with a locating rod passed through their lower ends. Chute widths are easily selected by manipulation of the bars. The equally-divided sample flows into two material pans located on either side of the chute. **Circle No. 6.**

Rescue Breathing Kit

A portable breathing kit is being distributed by the *American Optical Company*. Called the "Ambu," this kit contains a resuscitator which



functions on the principle of the mouth-to-mouth rescue breathing technique. This kit includes a foot-operated suction pump to clear the breathing passage. The unit requires no electricity or other connections and can be operated by one person. This method of artificial respiration minimizes the danger of infection. **Circle No. 7.**

(Continued on page 232)

Manufacturers News

(Continued from page 231)

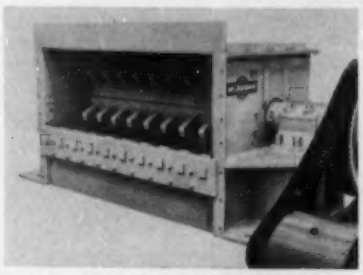
Frame Conveyors

A complete line of Cedarapids Lattice Frame Conveyors has been announced by *Iowa Manufacturing Co.* These conveyors have designed features for increased strength, rigidity,

and accurate alignment, together with pre-engineered standardized components that assure maximum flexibility and interchangeability with minimum assembly time required for field erection. A deep truss design with heavy side bracing increases conveyor strength without additional weight and provides high resistance to external stress. **Circle No. 8.**

Sinter Breaker

A breaker for crushing sinter as it is delivered from the sintering machine has been developed by *McLanahan & Stone Corp.* Using integral 9-in. hard-surfaced teeth to crush the sinter against special alloy grizzly bars, the breaker was developed for heavy duty, continuous



service in crushing extremely abrasive, high temperature materials. The machine is available in 72-in. and 94-in. widths, each with a roll diameter of 24 in. Water cooling is available for the crushing roll and roll shaft bearing. **Circle No. 9.**

Air Hose

A heavy duty, flexible air hose, capable of maintaining working pressure up to 400 psi, has been developed by *Dayton Industrial Products Co.* The "Maximair" features double-braided high tensile rayon construction and an abrasion-resistant Neoprene cover for maximum protection. The hose is available in 25-ft and 50 to 75-ft lengths with diameters up to 2 in. **Circle No. 10.**

Automatic Power Shovel

An improved automatic power shovel for unloading bulk materials from railway cars or long truck trailers has been announced by *Webster Manufacturing, Inc.* Known as "Webster No. 40," it is especially suitable for handling coal, lime, and cement and can be used with wood, aluminum or steel scoops. The shovel is available in single (575-lb weight) and double (1150-lb weight) types and is mounted on a rigid support 10 to 12 ft above the car door level. The mechanism features an exclusive reversing system which eliminates need for hazardous counterweights. It reportedly has 50 pct fewer working parts than many other unloaders. **Circle No. 11.**

Vibration Inducer

A high-amplitude vibration inducer, which starts and keeps materials moving during the unloading of railroad cars or hoppers, has been introduced by *Martin Engineering Company.* Called the "Vibrolator CCVP," this portable unit has its own mounting clamp and can be

placed in any position or angle. It is pneumatically-driven, shock-proof, and spark-proof. The CCVP, which operates at a low-noise level at all frequencies, can be precisely controlled at any vibration frequency from a few cycles to more than 60 cycles per sec. **Circle No. 12.**

Pushbutton Station

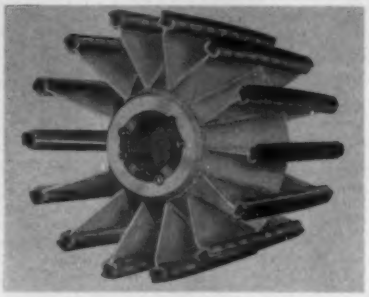
The "Pushbutton Station" has been developed by *Gemco Electric Company* for motor control use in hazardous areas. Housed in aluminum to prevent corrosion and sparking, this unit is designed to meet NEMA specifications. A major feature of this unit is that it can be provided with either 1) maintained two or three position contacts, or 2) momentary two position contacts. Padlock holes are provided on the side bosses to lock the contacts in any of three positions. **Circle No. 13.**

Concrete Placement Machine

Air Placement Equip. Co. has developed the "Uni-Cretor" designed for wet gunning, plus concrete, mortar, and grout placing. This 2200 lb machine is 76 in. long, 82 in. wide, 58 in. high and is powered by a 56-hp engine. **Circle No. 14.**

Wing Pulley

A rubber-lagged wing pulley (reportedly the first of its kind) has been introduced by *Van Gorp Mfg., Inc.* Named "Turn-Clean," the exterior edge of the wing consists of a U-shaped steel channel which receives a steel-encased rubber bar. This bar provides a surface which



will transmit maximum traction to the belt. The rubber lagging compresses on contact with the belt and, when the arc of contact is broken, the rubber will spring back to its normal height and automatically clean itself. These rubber bars grip the belt tightly and spall off dried material on the underside of conveyor belts, thus minimizing the need for pulley cleaning shutdowns. **Circle No. 15.**

Two-Way Radio

General Electric has engineered a low-priced ($419), lightweight (10 lb.), compact (4¼ in. high, 7¾ in. wide, 12½ in. long) two-way radio for use in the mining industry. The Pacer operates in low band (27-50 mc) and high band (150-174mc) and the units have VHF-FM audio.

This 15-watt unit, designed to fit in the smallest cars, does not require special generators or heavy-duty batteries. Its control section has a power supply adaptable to 12-v negative or positive ground electrical systems. **Circle No. 16.**

Coal Elevating Conveyor

Development of a portable chain and flight-type coal elevating conveyor with a surge hopper has been announced by *The Nolan Co.* A special feature is the installation of the mother belt on a horizontal plane instead of the usual incline normally required in conventional designs to reach the top of the loading chute. The standard "Loadveyor Model C-200" has a capacity of 500 tph, with a surge bin capacity of 2 tons. It is reported that higher capacity units will also be available. **Circle No. 17.**

(21) BLASTING AGENT: A four-page folder recently issued by *Intermountain Research & Engineering Co.* describes the advantages of slurry blasting agents over ammonium nitrate/fuel oil mixture. Termed "Dense Blasting Agents" and designed for blasting in wet or dry holes in underground and open pit mines, the explosive compound contains water which increases its safety as well as its explosive force. A comparison table of the strength of the two agents is accompanied by an analysis of their respective performance and cost, made by Iron Ore Co. of Canada.

(22) TRUCK CRANE: A comprehensive 16-page technical portfolio showing the features and capabilities of its new P&H Model 255B-TC truck crane has been released by *Harnischfeger Corp.* The brochure includes complete operating specification of each front end attachment and tables showing axle loadings with each length crane boom available for the unit. There are 22 capacity charts, seven general dimension drawings, a crane range diagram, seven cutaway photographs and 10 photos of the crane in action. Both English and metric figures are given for important weights and dimensions.

(23) ROPEBELT CONVEYOR: An eight-page catalog (G-150) describing the Ropebelt conveyor with flexible idlers has been issued by *Goodman Mfg. Co.* The booklet contains diagrams of belt construction, terminal sections, and typical set up. Photographs of the conveyor operating in a number of representative situations are included.

(24) BLASTHOLE BITS: A 12-page mining and quarrying catalog featuring specifications and engineering data for "Super-Aire" heavy-duty, rotary blasthole bits has been published by *Security Engineering*, a division of *Dresser Industries*. The booklet includes an air drilling guide plus illustrations of the bit types.

FREE LITERATURE

(25) CAREERS IN THE MINERAL INDUSTRY: "Opportunities Unlimited", a booklet designed to introduce high school and college students to the various careers available in the extractive industry, may now be obtained from the Society of Mining Engineers of AIME. Describing the various aspects of the industry, from exploration to mineral beneficiation, the booklet also discusses such subjects as secondary and college training, selecting a college, the cost of a college education, and the opportunities awaiting a new graduate in mineral engineering.

(26) EQUIPMENT FOR MINERAL AND CHEMICAL PROCESSING: An eight-page bulletin (No. G3-B74) from *Denver Equipment Co.* contains photographs and specifications for 44 different items available from the company for use by the mineral and chemical processing industries. Three of these are new items: the Tru-Glandless pump, the laboratory flotation machine, and the attrition machine. The pamphlet also contains descriptions of Denver's laboratory testing service and its engineering and mill design services.

(27) MINING EQUIPMENT: A complete pocket catalog has been published by *The American Mine Door Co.* which illustrates all of the company's products, including mine doors, dusters, car transfers, and track cleaners switch machine and controls. This 16-page booklet contains photographs of the equipment and specifies more detailed bulletins available from the firm.

(28) PORTABLE DREDGE: Full-color illustrations of several job applications of the Dixie-Dredge are featured in an eight-page bulletin (No. 658) from *Service Machinery Corp.* The booklet describes and illustrates the principle features of the dredge and includes a table of standard specification data.

(29) VIBRATING GRIZZLY FEEDERS: Bulletin No. C900P issued by *Carrier Div., Chain Belt Co.*, describes the company's natural-frequency vibrating grizzly feeder line. This eight-page pamphlet outlines the advantages of the feeder's remote control system and details its exclusive amplitrol drive that uses natural frequency to produce more work with less power consumption.

(30) E. M. GUN: A single-sheet flyer, Geophysical Instrument Bulletin BM 0860, from *The Abem Co.* describes equipment for ore prospecting by electromagnetic inductive methods. It furnishes details of the equipment's features including transmitter, receiver, staff separation, and depth penetration.

(31) BLASTING: A reprint of L. Don Leet's article "Vibrations from Construction Blasting", originally published in *The Explosives Engineer*, has been issued by *Hercules Powder Co.* The article discusses those vibrations which are unique to construction blasting and of the consequent safe vibration limits for structures in their path. The effectiveness and performance of various types of explosives and explosive arrangements are analyzed in relationship to the resultant crater area and rock jointing. Other matters considered in this 24-page booklet are: elasticity and characteristic impedance as they relate to blasting vibrations; the value of the seismograph in establishing accurate vibration data; and the interrelationship of the safe limits of potential crater area and the zone of elastic vibrations to the quantity of explosives and distance.

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Students should write direct to manufacturer.

(32) JAW CRUSHER: Bulletin 132-60A released by *Universal Engineering Co.* covers the salient features of the big "4848" overhead eccentric jaw crusher. With a top-rated capacity of 950 tph set at 12 in., it is equally adaptable to ore mines and quarry operations.

(33) MOTOR CONTROLLER: *Allis-Chalmers Mfg. Co.* has issued its eight-page bulletin 14B9739 to introduce the SpaceMaker controller for high voltage control. Design features and advantages are described and illustrated with photographs of the unit's components. The controller is now available for squirrel-cage, wound-rotor, and synchronous motors up to 2500 hp at 4 to 5 kv and to 1500 hp at 2.3 kv in reversing or non-reversing, full-voltage or reduced-voltage starting.

(34) MOTORIZED WHEEL DRIVE: Twelve-page bulletin GED-4261, describing the motorized wheel drive developed for operators of off-highway equipment, was recently issued by *General Electric Co.* to supersede an earlier bulletin on the subject. Photographs and drawings show earth-hauling vehicles using the equipment, and offers a haulage study for potential users.

(35) TRAXCAVATOR: The 12-page, illustrated booklet No. 34004 describes at length the engineering details of the 922 Series A Traxcavator which assure quick response performance, operator safety and convenience, greater ease of servicing, and versatility. This brochure from *Caterpillar Tractor Co.*, contains on-the-job photographs, diagrams and charts, specifications, and a selection of attachments to increase the machine's versatility.

(36) AIR COMPRESSOR: *Gardner-Denver Co.* has issued a single-sheet flyer to announce its Model WFO air compressor. Bulletin 1-1V includes a photograph of the unit and general data charts for bare compressor and complete compressor.

(37) PLATE FEEDER: The conveyor and process equipment division of *Chain Belt Co.* recently released a seven-page bulletin, No. 6094P, describing the Rex Reciprocating Plate Feeder. The booklet contains outlined drawings, dimensions, and selection aids covering the standard line. It also lists feeder specifications such as capacity and horsepower, and highlights the five types of Rex eccentrics available for the feeder.

(38) DIESEL ENGINES: Features of the recently introduced Models 10000 and 11000 diesel engines are described by the illustrated text of an eight-page catalog issued by *Engine-Material Handling Div., Allis-Chalmers Mfg. Co.* Performance curves and charts, and illustrations including cutaways of important components are featured in the booklet.

(39) WET MAGNETIC DRUM SEPARATORS: A four-page color brochure has been issued by *Stearns Magnetic Products* describing its complete line of wet permanent magnetic drum separators. Bulletin No. 2013 gives specifications and dimensions for all available sizes plus selection information.

(40) HOSE STYLE SELECTION GUIDE: The "A-to-Z" of industrial hose style selection is charted in the 12-page bulletin No. 627, recently released by *Aeroquip Corp.* It serves as a guide for proper hose selection for virtually every industrial application, listing 112 separate liquids and gases, beginning with acetate solvents and ending with zinc salt solutions. The suitability of various Aeroquip Hose tubestocks for use in carrying these diverse agents is charted in four separate classifications: excellent, good, conditional, and unsatisfactory. The charts indicate tubestock suitability only; a separate chart provides fundamental information about the pressure, temperature, and size limits of the individual hose types available from the company.

(41) VIBRA SCREW FEEDERS: Tested performance of screw feeding equipment for 456 different dry materials from abrasives to zinc stearate is described in a new eight-page folder issued by *Vibra Screw Feeders Inc.* Maximum rates of feeding ranges from 0.1 lb per min for an abrasive to 1000 lb per min for stone dust. The booklet indicates the density in lbs per cu ft for each material, the screw size of the feeder, maximum rate in lb per min and the pct of accuracy and consistency.

(42) TIMING BELT DRIVES: *T. B. Wood's Sons Co.* has issued 80-page catalog No. 19103, giving all the information needed to select the proper timing-belt drive with a minimum of arithmetic. The booklet features a series of charts designed to provide graphical solutions rather than tedious numerical calculations. One full-page chart enables graphic selection of the proper pitch from the factors of design horsepower and speed of the pulley of largest rpm; other full-page charts are given for drive-width selection for each of the five pitches. Twenty-seven pages of drive tables allow determination of driven pulley and belt pitch length when the speed ratio and driver pulley are known. In addition to the numerous charts, the book includes a description of belt drive features, illustrations of typical applications, and description and diagrams of construction details.

(43) CHAIN SLINGS: *Wire Rope Div., Jones & Laughlin Steel Corp.* recently published a 16-page illustrated brochure giving the specifications and working load limits of its line of alloy chain slings, rings, links, and hooks. It also discusses the advantages of alloy chain slings over wrought iron or carbon steel chain and the design advantages of "Jal-link," the company's permanent, tamper-proof alloy chain connector link.

(44) CENTRIFUGAL PUMPS: Bulletin 720.5 from *Goulds Pumps Inc.* introduces a new line of single stage side suction open impeller pumps to meet requirements in the chemical process and allied industries where relatively small quantities of corrosive chemicals or slurries, thick or abrasive, must be handled for heads up to 150 ft. The four-page leaflet includes specification data, charts on ratings, interchangeability, and construction details, as well as detailed diagrams of the pump.

(45) WATER RESOURCES: From *Caterpillar Tractor Co.* comes a 16-page booklet entitled "Water Bill U.S.A." This publication discusses our national water problem which is becoming more acute day by day and tells of ways in which Americans are working to solve it with better farming practices and watershed control programs.

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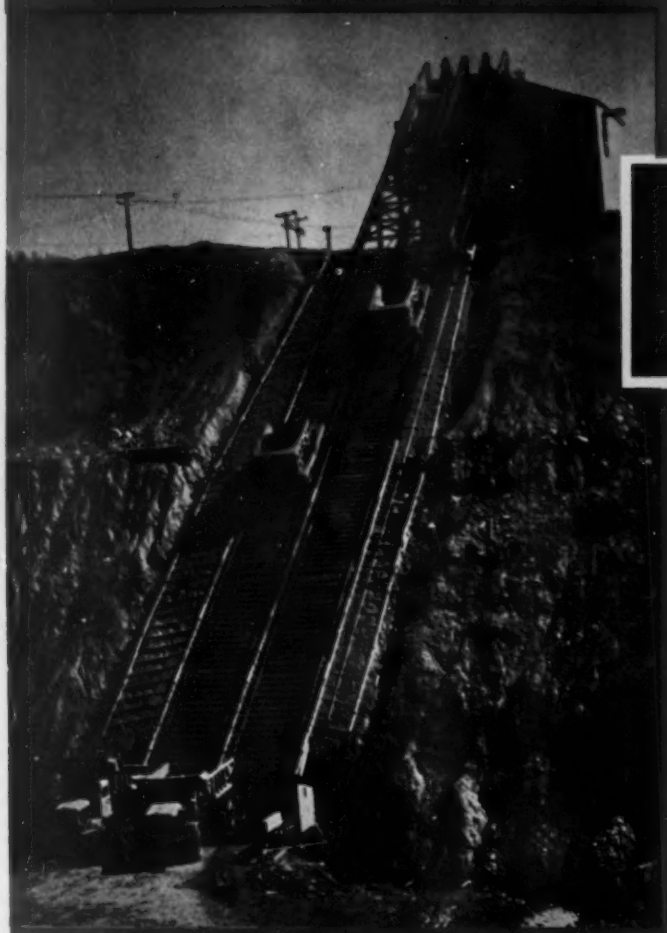

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Garfield Smelter Improvements Planned

Kennecott Copper Corp. has started work on a $5-million project to construct a new materials handling system and other improvements for its copper smelter at Garfield, Utah. Scheduled for completion about June 1962, the new system will permit direct feeding of concentrates to the reverberatory furnaces, eliminating the present roasting process. The furnaces are to be converted to accept the green feed which will permit cutting process time in the production of copper anodes at the plant.

Low Grade Magnetic Iron Project in Michigan

Plans for an open pit mine and beneficiation plant near Negaunee, Mich., have been announced by Empire Mining Co., operated by Cleveland-Cliffs Iron Co. The ore is a magnetic iron-bearing jasper containing about 30 pct Fe, and the project marks the first development in Michigan of a low grade magnetic iron orebody. The concentrator will have an initial annual capacity of more than a million tons of 65-pct Fe pellets. The new Empire mine will bring the pellets produced yearly by Cleveland-Cliffs and partners in the Marquette range area to 3¼ million tons when it is completed, possibly by 1963.

Wabush Iron Plans Large 1961 Outlay

Wabush Iron Co. Ltd. has slated a $20-million expenditure this year to pave the way for developments scheduled to bring a large Labrador iron deposit to annual production of 4 to 5 million tons of high grade concentrate in 1965. Wabush said $15 million of the allotted funds will be used for construction of ore loading docks and ore storage facilities. The balance will go to housing and other facilities for 1200 construction workers.

Kennecott Sells Merriespruit and Virginia Gold Interests

Kennecott Copper Corp. has divested itself of its interests in the South African gold properties, Virginia Orange Free State Gold Mining Co. Ltd., and Merriespruit (Orange Free State) Gold Mining Co. Ltd. The sale, to a South African firm formed by a syndicate headed by C. W. Engelhard, chairman of Rand Mines Ltd., will bring Kennecott a maximum of some $17 million. This involves a considerable loss for the company, which has invested a total of about $46 million in the properties. A decrease in metal values and flooding at the mines were cited as reasons for the sale, which was said to be "in the best interests of the company." The loss is to be charged against earned surplus, the company said, and "for Federal tax purposes it constitutes a capital loss carry-forward to be applied against any corporate capital gains that may be realized during the next five years."

California Asbestos Project Planned

Johns-Manville Corp. and the Kern County Land Co. of San Francisco announced plans for a mine and mill to work a 1500-acre, high grade asbestos deposit at Coalinga in central California. The two firms have formed an operating company called Coalinga Asbestos Co. Inc., in which Johns-Manville owns the majority interest. Surface mining methods will be used, and the projected mill will be built at the deposit to process fiber for the manufacture of asbestos-cement, asphalt-asbestos, and vinyl-asbestos products.

MINING engineering REPORTER

New Copper Output Cutbacks Announced

Kennecott Copper Corp. announced that operations at its mines in Arizona, Nevada, New Mexico, and Utah were reduced from 7-day to 6-day work weeks, effective February 1. Output thus reduced was about 4500 tons of refined metal per month, or about 12.5 pct of domestic production by the company. Anaconda Co. said it was making an immediate 10-pct cutback at its U. S. operations, and at the Chuquicamata and El Salvador mines in Chile. Inspiration Consolidated Copper Co. reduced production to 90 pct of capacity at its Arizona properties.

Senator Proposes World Copper Controls

Senate Majority Leader M. Mansfield of Montana has asked President Kennedy to call "an international copper conference to stabilize prices on a world-wide basis, to encourage production on a year-round basis," and said he had concluded "in view of world conditions that the only way to face up to the ups and downs which prevail in the copper industry is a cartelization of sorts, under careful supervision, agreed to and supported by the copper-producing nations of the world."

AEC Extends Wyoming Mill Contract

A uranium concentrate purchase contract between the AEC and Susquehanna-Western Inc., which operates a 500-tpd processing plant at Riverton, Wyo., has been extended to December 31, 1966. The original contract called for a total expenditure of $22.9 million for concentrate produced between July 1, 1960, and the expiration date, October 31, 1963. The new arrangement effective as of June 1, 1960, provides for Government purchase of concentrates, valued at about $47 million, through December 31, 1966.

Geological Map of Asia Completed

An Asian Regional Geological Map is now available as a result of a six-year effort sponsored by the Economic Commission for Asia and the Far East. Asia was the sole remaining continent to lack such a reference. Copies are available through the Bangkok headquarters of ECAFE. Other specialized regional maps showing known and potential mineralized areas are in preparation.

Peabody Plans New Capital Spending

Peabody Coal Co. plans a capital investment of $50 million directed primarily at preparing mine facilities to fulfill a 17-year contract for 65 million tons of coal for the Tennessee Valley Authority near Paradise, Ky. The spending program will cover a three-year period.

Webb & Knapp Sells Montana Steel Project

Gulf States Land & Industries Inc., a subsidiary of Webb & Knapp Inc., has purchased from the parent firm a project to convert waste copper smelter slag to steel. In exchange for common shares, Webb & Knapp has turned over to Gulf States: its contract with Anaconda Co. to buy slag from a 40 million ton pile at Anaconda, Mont.; sales agreements with steel producers who will buy portions of the output of the project; interest in the required metallurgical processes; and an electric power contract. The move is intended to simplify future financing of the project.

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BOOKS

(Continued from page 229)

STATE PUBLICATIONS

New Mexico

Bureau of Mines and Mineral Resources
Campus Station
Socorro, N. M.

Trail Guide to the Upper Pecos, Scenic Trips to the Geologic Past No. 6, 1960, $1.00.
Magnetite Taconite Rock in Precambrian Formation in Rio Arriba County, New Mexico, Circ. 54, 1960, gratis.
Some Scheelite Occurrences in the Magdalena Mining District of New Mexico, Circ. 55, 1960, 20¢.
Geologic Research in New Mexico during 1959, Circ. 56, 1960, 30¢.

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Use of Pressure Grouting to Stabilize Ground in the San Manuel Mine by *J. W. Goss* and *M. J. Coolbaugh*—Most grouting has been done to stop water flow in mines and for stabilizing foundations of various man-made structures, a survey of the U.S. literature reveals. Apparently San Manuel is one of the first mines in this country to use grout extensively underground for strengthening and stabilizing ground in drifts, shafts, and stations. A comparison with other procedures, as well as details of the San Manuel program are covered. **Ref.** (MINING ENGINEERING, **March 1961**) **p. 255.**

Mechanized Tamping of Mine Haulage Roads by *D. H. Davis*—Considerable time, effort, and money have been expended to improve productivity in coal mines. Modern mechanical methods can also be applied to such operations as railroad-bed construction, heretofore primarily a manual job. The use of a mechanical tamper for improving roadbeds at the Mathies mine of Consolidated Coal Co. is described in detail. A study of performance records for both new construction and maintenance indicates the advantages of devising better methods for various coal-mine construction jobs. **Ref.** (MINING ENGINEERING, **March 1961**) **p. 262.**

The Role of the Geologist at Butte by *Edward P. Shea*—Since 1900, when it was organized, Anaconda's geological department at Butte has successfully employed standardized methods. Guided by the geologic record, the geologist works closely with mine operators, pursuing a policy of developing at least one ton of new ore to replace every ton mined. A formal estimate of reserves is made on the first of each year, and the geologist estimates the tonnage developed weekly to determine the current status. A geological research department with a well equipped laboratory is maintained to investigate rock alteration, and extensive studies are in progress to relate alteration to mineralization and grade in both vertical and horizontal dimensions. An exhaustive study of Butte mineralogy is under way to obtain better knowledge and understanding of the behavior of the ore minerals at the time of deposition. This information will be used to predict deep-level possibilities and locate the zones of better copper mineralization. The value of former records is demonstrated by comparatively recent projects—such as the Kelley and Elm Orlu cave mines and the Alice and Berkeley pits—which originated in the geological department. **Ref.** (MINING ENGINEERING, **March 1961**) **p. 264.**

(Continued on page 242)

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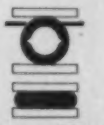

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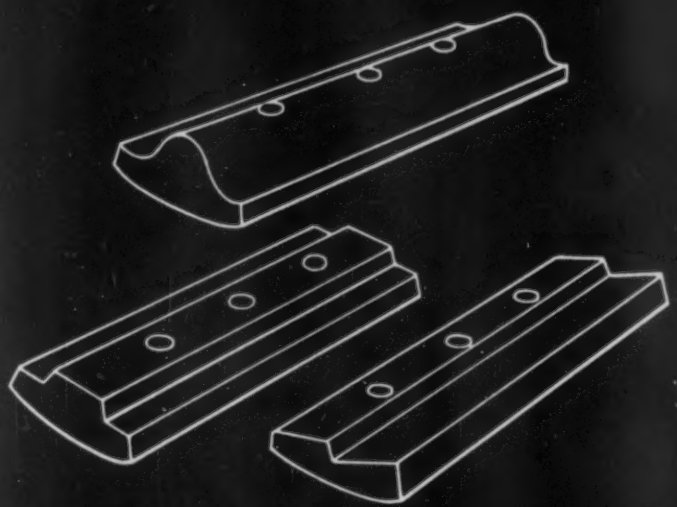

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ABSTRACTS

(Continued from page 241)

Economic Justification for Froth Flotation of Coal by *J. W. Miller*—Competition due to depressed markets has developed to a high degree in the coal industry—a competition demanding that each company examine every possibility of improving its mining operations and to project the maximum recovery at the lowest operating cost. For some operations, there are economic factors determining capital expenditures for a froth flotation installation; this is not justified costwise for others. One determining factor is the pay-off on investments. **Ref.** (MINING ENGINEERING, **March 1961) p. 269.**

Hydraulic Transportation of Florida Phosphate Matrix by *Harvey B. Hardy* and *Svend A. Canaris; J. L. Wester; Matthew T. Smith;* and *U. K. Custred*—Analysis of the hydraulic transportation methods employed by four phosphate mines in Florida. The equipment and procedure for transporting the ore from mine to plant is described for the Fenoroc, Sydney, Achan, and Noralyn mines. **Ref.** (MINING ENGINEERING, **March 1961) p. 274.**

Measurement of Rock Pressure with a Hydraulic Cell by *Louis A. Panek*—During the past three years the USBM has developed an apparatus and technique for direct measurement of existing pressure and change of pressure in mine rock. This relatively simple and inexpensive monitor is reliable for months after being installed. It is used to determine shift of ground pressure created by different sequences of mining, to ascertain the cause of rock failures, and to evaluate the need for artificial support. The technique has been employed to measure pressures in limestone, greywacke, concrete, diabase, and soft iron ore. **Ref.** (MINING ENGINEERING, **March 1961) p. 282.**

PERSONNEL

(Continued from page 226)

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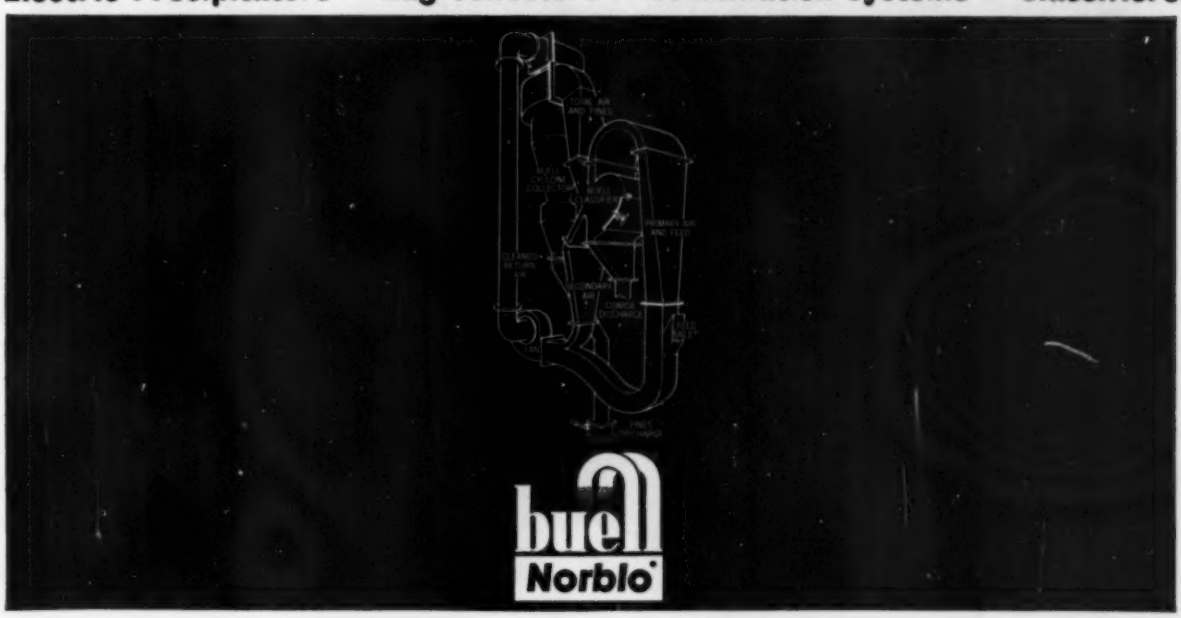

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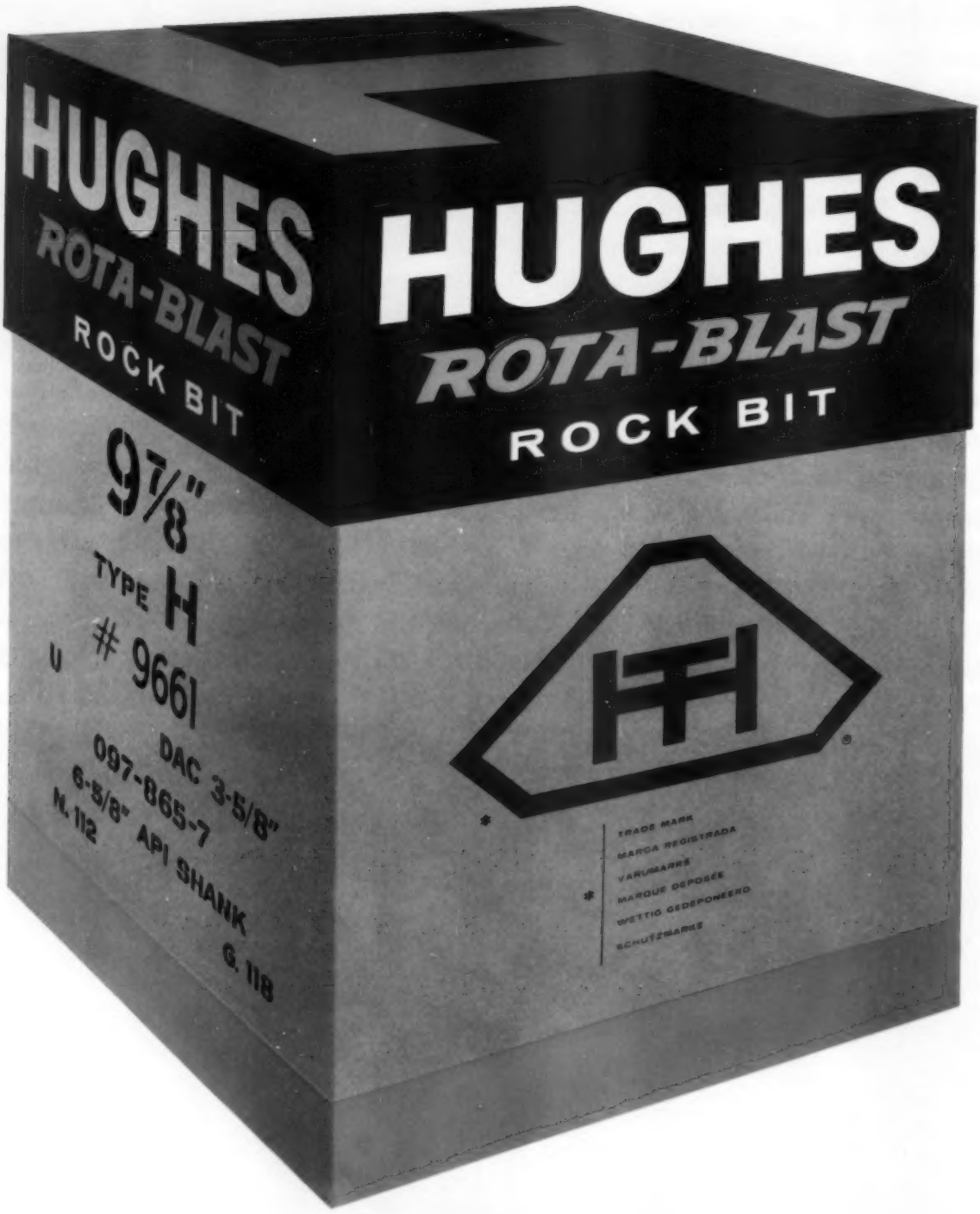

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COAL (F)

Bowman, E. V., and Hurst, E. J.: *Material Handling Aspects of Fine Coal Cleaning*, **61F68.**

Boyle, J. A., and Conn, O. S.: *Control of Mine Ventilation Utilizing Multiple Main Fans*, **61F49.**

Elliott, M. A.: *Coal Gasification for Production of Synthesis and Pipeline Gas*. **61F61.**

Hamilton, G. M.: *Gasification of Solid Fuels in the Wellmann-Galusha Gas Producer*, **61F8.**

Hightower, T. R., and Mellor, M. W.: *Thunderbird Collieries*, **61F64.**

Jamison, R. H., Jr.: *Full Dimension Systems*, **61F36.**

MacDonald, J. W.: *Coal Preparation Plant Facilities, Old Ben Mine No. 21, Sesser, Franklin County, Illinois*, **61F69.**

Macpherson, H.: *Froth Flotation in Durham Division of National Coal Board*, **61F42.**

Miller, J. W.: *Economic Justification for Froth Flotation*, **61F66.**

Mongan, C. E., Jr., and Miller, T. C.: *Use of Sonic Techniques in Exploring Coal-Mine Roof Strata*, **61F33.**

Oppelt, W. H., and Kube, W. R.: *Bench-Scale Experiments on Low-Temperature Carbonization of Lignite and Subbituminous Coal at Elevated Temperatures*, **61F1.**

Oppelt, W. H., and Gronhovd, G. H.: *Design and Preliminary Operation of a Slagging Fixed-Bed Pressure Gasification Pilot Plant*, **61F18.**

Orlandi, W. J.: *Requirements and Advantages of An All-Belt Mine Haulage System*, **61F9.**

Parisi, C. W.: *Use of High Expansion Foam on an Actual Mine Fire*, **61F70.**

• Peters, J. T., and Shapiro, N.: *Know Your Coal*, **61F62.**

Risser, H. E.: *Adaptability of Illinois Coal for Use in Iron and Steel Production*, **61F30.**

Sallmann, K.: *German Coal Flotation—1960*, **61F80.**

Valeri, M.: *Continuous Mining in the Pittsburgh Seam*, **61F46.**

Washburn, H. L., and McConnell, W. A.: *Design of Loveridge Plant*, **61F58.**

Weimer, W. A.: *Peabody Coal Company's "River King Mine,"* **61F59.**

• Wotring, R. W.: *Lee-Norse Miner in the No. 4 Pocahontas Seam*, **61F63.**

Wright, F. D.: *Maximizing the Profit of a Coal Preparation Plant by Linear Programming*, **61F16.**

ECONOMICS (K)

Douglas, T. B.: *Economics of 5½ Mile Transport Conveyor Belt at Ideal Cement Company's Ada, Oklahoma, Plant*, **61HK28.**

Dubnie, A.: *Transportation of Minerals in Northern Canada*, **61K11.**

Eisemann, E. F., Jr.: *Some Aspects of Competition Between Fuels in the United States*, **61K89.**

Gritzuk, N.: *Long Haul Transportation of Minerals in Canada's Far North West*, **61HK34.**

Jaworek, W. G., and Schanz, J. J., Jr.: *Fuel Interchangeability—Measuring Its Extent in U.S. Energy Markets*, **61K43.**

Lasky, S. G.: *Mineral Self-Sufficiency*, **61K4.**

Lentz, O. H.: *The Depletion Rationale and Recent Political Pressures of Erosion*, **61K91.**

Quinn, F. J.: *Natural Gas and the Competitive Fuel Market*, **61K90.**

Riggs, W. A.: *Transportation Economics of Mineral Commodities*, **61HK19.**

Robinson, M. E., and Kurtz, W. L.: *Competitive Markets—The Fossil Fuels*, **61K23.**

Roetzer, A. A.: *Materials Handling, Transportation, and What Lies Ahead in Packaging in the Cement Industry*, **61HK50.**

• Wilhelmy, O., Jr.: *Water Transportation of Fertilizer Raw Materials*, **61HK75.**

• Young, R. A.: *The Quota System in Mining—Particularly Lead and Zinc*, **61K96.**

EDUCATION (J)

• Forrester, J. D.: *The Future for Educational Training of Mineral Industry Engineers*, **61J98.**

• Just, E.: *Preparing Men for Mining's Future*, **61J97.**

• Reed, J. J.: *The Interdependence of Mining Education, Research, and the Industry*, **61J99.**

GEOLOGY (I)

Baker, A., III, and Scott, B. C.: *Geology at the Pitch Mine*, **61I53.**

• Blais, R. A., and Stubbins, J. B.: *The Role of Mining Geology in the Exploitation of the Iron Deposits of the Knob Lake Range, Canada*, **61I101.**

Freeze, A. C.: *Use of Punch Card Accounting Machines in Calculating Reserves at Sullivan Mine*, **61I85.**

Perry, V. D.: *The Significance of Mineralized Breccia Pipes*, (Jackling Lecture) **61I78.**

Shea, E. P.: *The Use of Geology in Butte*, **61I29.**

GEOPHYSICS (L)

Fahnestock, C. R.: *Use of Seismic Techniques in Analyzing Subsurface Materials*, **61L45.**

Heyburn, M.: *Geologic Mapping with the Aid of Magnetics, Tahawus Area, New York*, **61L13.**

Misech, A. F., and Riley, L. B.: *Basic Statistical Measures Used in Geochemical Investigations of Colorado Plateau Uranium Deposits*, **61L37.**

Whitten, E. H. T.: *Quantitative Distribution of Major and Trace Components in Rock Masses*, **61L17.**

INDUSTRIAL MINERALS (H)

Barnes, R.: *Perlite—A Review*, **61H83.**

• Barr, H. W., Jr.: *Problems in Gaging Markets for Specialty Fillers*, **61H100.**

Blair, L. R.: *Synthesis of Inorganic Silicate Fillers and Filter Aids*, **61H76.**

• Bleimeister, W. C.: *Rock Salt Mining and Economics in the North Central Area*, **61H92.**

Czel, L. J., and O'Brien, W. F.: *Lithium Horizons*, **61H60.**

• Dole, H. M.: *Mining vs Public Land Withdrawals*, **61H55.**

Douglas, T. B.: *Economics of 5½ Mile Transport Conveyor Belt at Ideal Cement Company's Ada, Oklahoma, Plant*, **61HK28.**

Goldman, H. B.: *Urbanization and the Mineral Industry*, **61H24.**

Gray, J. E.: *Specifications for Mineral Aggregates*, **61H82.**

• Golson, C. E., and Newton, D. E.: *Application of Metallurgical Principles, Processes, and Equipment to the Production of Mineral Aggregates*, **61H87.**

Gritzuk, N.: *Long Haul Transportation of Minerals in Canada's Far North West*, **61HK34.**

Herfindahl, O. C.: *Conflicts Between Mining and Other Economic Activities—A General View*, **61H74.**

Jackson, T. M., and Jones, R. K.: *The Role of Organic and Inorganic Fibers in Gaseous and Liquid Filtration*, **61H79.**

Kienitz, L.: *Better Aggregate Processing Pays Off*, **61H44.**

Landes, K. K.: *Chemical and Metallurgical Limestone in North Central, Northeastern States, and Ontario*, **61H41.**

• Lemish, J.: *Research in Carbonate Aggregate Reactions in Concrete*, **61H95.**

Maddock, T., Jr., *Quarrying or Mining Versus Water Reservoirs*, **61H31.**

Mussey, O. D.: *Water: Its Role in Mining and Beneficiating Iron Ore*, **61H81.**

Price, W. L.: *Wire Cloth and Perforated Plate for Vibrating Screens* (NSGA Circular #80), **61H71.**

Riggs, W. A.: *Transportation Economics of Mineral Commodities*, **61HK19.**

Roetzer, A. A.: *Materials Handling, Transportation, and What Lies Ahead in Packaging in the Cement Industry*, **61HK50.**

• Wilhelmy, O., Jr.: *Water Transportation of Fertilizer Raw Materials*, **61HK75.**

Williams, V. C.: *Saline Water Conversion Economics*, **61H38.**

Wollman, N.: *Our Future Water Needs—PMPC Forecast vs RFF Estimate*, **61H32.**

MINERALS BENEFICIATION (B)

Bailey, C. N.: *Economic Factors Affecting Design of a Milling Plant*, **61B88.**

Bergstrom, B. H., and Sollenberger, C. L.: *Kinetic Energy Effect in Single Particle Crushing*, **61B94.**

Bond, F. C.: *Principles of Progeny in Comminution*, **61B15.**

Bowdish, F. W.: *Theoretical and Experimental Studies of the Kinetics of Grinding in a Ball Mill*, **61B2.**

Brown, W. N.: *Innovations in Large Volume Warehousing and Handling of Bulk Materials*, **61B72.**

Browning, J. S.: *Flotation of North Carolina Spodumene-Beryl Ores*, **61B20.**

Curtis, C. H.: *The Esperanza Concentrator*, **61B77.**

Dor, A.: *Recent Trends in Iron Ore Beneficiation and Their Effect on Mill Design and Layout*, **61B54.**

Dresher, W. H.: *A Mechanism Study of the Formation of Sodium Vanadate Compounds Under the Conditions of the Salt-Roast Process*, **61B48.**

Gaudin, A. M., and Fuerstenau, M. C.: *Determination of Particle Size Distribution by X-Ray Absorption*, **61B3.**

Helfrich, W. J., and Sollenberger, C. L.: *Relative Reduction Rates of Porous Iron Oxide Pellets*, **61B52.**

Hoffman, I., and Mariacher, B. C.: *Beneficiation of Israeli Phosphate Ore*, **61B57.**

• Howell, F., and Stoehr, R. J.: *Handling and Drying of Wet Ambrosia Lake Ores*, **61B93.**

Larsen, E. P.: *Blending and Handling of Materials for Agglomeration*, **61B22.**

Lash, L. D., and Ross, J. R.: *Scandium Recovery from Vitro Uranium Solutions*, **61B51.**

Levine, N. M., and Fassel, W. M.: *The Technique of Gas Oxidation During Pulp Agitation*, **61B10.**

Li, K. C.: *Chemical Processing of Tungsten Ores and Concentrates*, **61B7.**

Peirce, J. W.: *Mass Flow Measurement of Mine Slurries*, **61B86.**

Raring, R. H., and Murray, G. Y.: *Effect of Mining Operation and Tailings Disposal Requirements on Mill Design*, **61B39.**

Sather, N. J.: *Concentrator Operation at the Bunker Hill Company*, **61B5.**

Speers, E. C., and Woodruff, F. G.: *Materials Handling Facilities at the Ray Mines Division Expansion Program*, **61B14.**

Sudbury, M. P., and Petkovich, F.: *Exothermic Hardening of Copper-Nickel Sulphide Agglomerates*, **61B40.**

Takahashi, Y.; Serizawa M.; Miyagawa, K.; and Shimomura, Y.: *New Process in Sintering of Fine Iron Ores*, **61B6.**

Thompson, C. D.; Czako, C. A.; and Violetta, D. C.: *Beneficiation of Cement Raw Materials by Dwight-Lloyd Processes*, **61B12.**

MINING (A)

(*Research Symposium;* **61AI02**).

• Just, E., and Parks, G.: *Research in Mining*, **61AI02A.**

• Carpenter, R. H.: *Research in Exploration*, **61AI02B.**

• Bates, C.: *Underground Nuclear Testing Detection, VELA UNIFORM, and Mineral Technology*, **61AI02C.**

• Lyon, R. J. P., and Westphal, W. H.: *Future Trends in Mining and Exploration*, **61AI02D.**

OPEN PIT MINING (AO)

Lackey, V. D.: *The 'Lectra Haul' Truck and Its Use on the Mesabi*, **61AO73.**

• Pfleider, E. P., and Dufresne, C.: *Transporting Open Pit Production by the Truck-Ore Pass-Adit System*, **61AO56.**

Stewart, R. M., and MacQueen, C. W.: *The Electric Wheel Truck in Anaconda's Operations*, **61AO84.**

Vickers, E. L.: *Application of Marginal Analysis in the Determination of Cut-Off Grade, The* **61AO21.**

UNDERGROUND MINING (AU)

Lang, T. A.: *Theory and Practice of Rock Bolting*, **61AU35.**

Morlan, E. A.: *Boring Large Hole Mine Openings*, **61AU27.**

Panek, L. A.: *Measurement of Rock Pressure with a Hydraulic Cell*, **61AU47.**

Ryon, J. L., Jr.: *Underground Use of Ammonium Nitrate-Fuel Oil Explosives*, **61AU25.**

Waples, B. R., Jr.: *Alimak Raise Climber at Iron King Branch of Shattuck Denn Mining Corporation*, **61AU26.**

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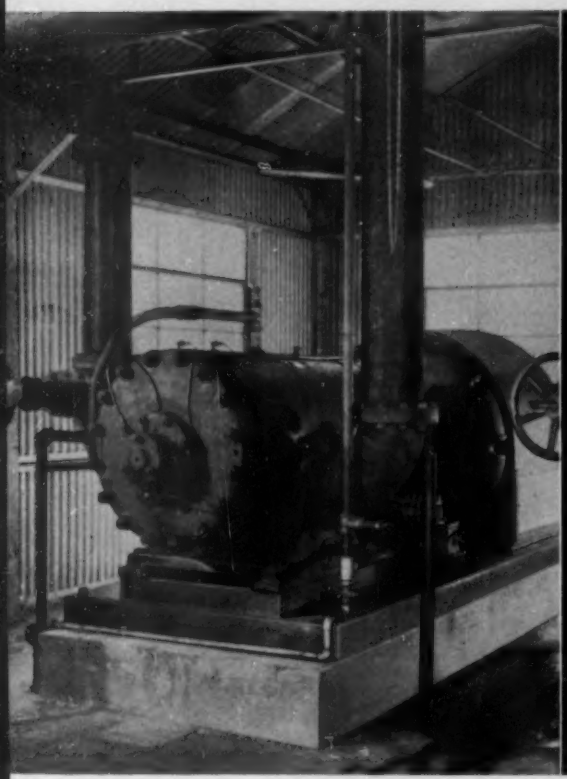

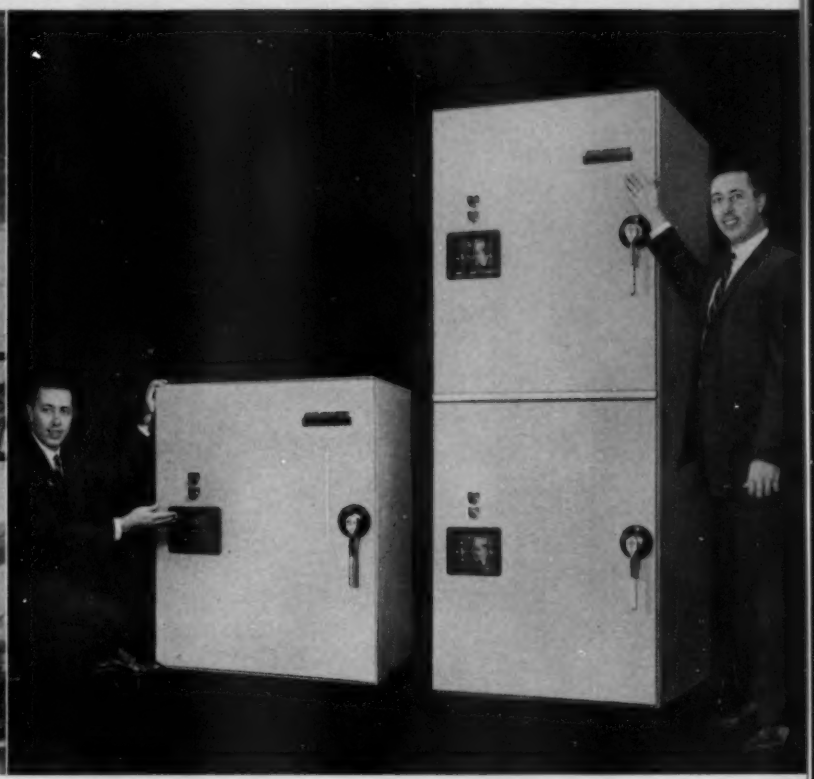

Constant vacuum . . . year after year: Ro-Flo vacuum pumps with sliding-vane rotary design eliminate operating losses inherent in reciprocating machines. Centrifugal force keeps vanes in close contact with cylinder walls, automatically compensating for wear. In addition, few moving parts required, reduce wear, simplify maintenance.

So low, two fit where one used to go: This new SpaceMaker control center is the first completely new 2- to 5-kv motor controller development in more than a decade. New compact two-high design can cut floor space requirements in half. Complete drawout construction makes it the safest, most easily accessible controller on the market. New flame-retardent, track-resistant Super Pyro-Shield insulation adds to reliability, reduces size and weight. And, the all-new roll-out contactor has been designed specifically to cut maintenance time and costs.

Which of these productive ideas could be working for you?

A system that makes low-grade ore valuable. New motor controls that save space. Where could your company apply these? What about all the rest of the idea-filled products which result from the A-C "usefulness" concept of design? Have an application? Call your A-C representative for information. Or write Allis-Chalmers, Industrial Equipment Division, 906 S. 70th St., Milwaukee 1, Wis.

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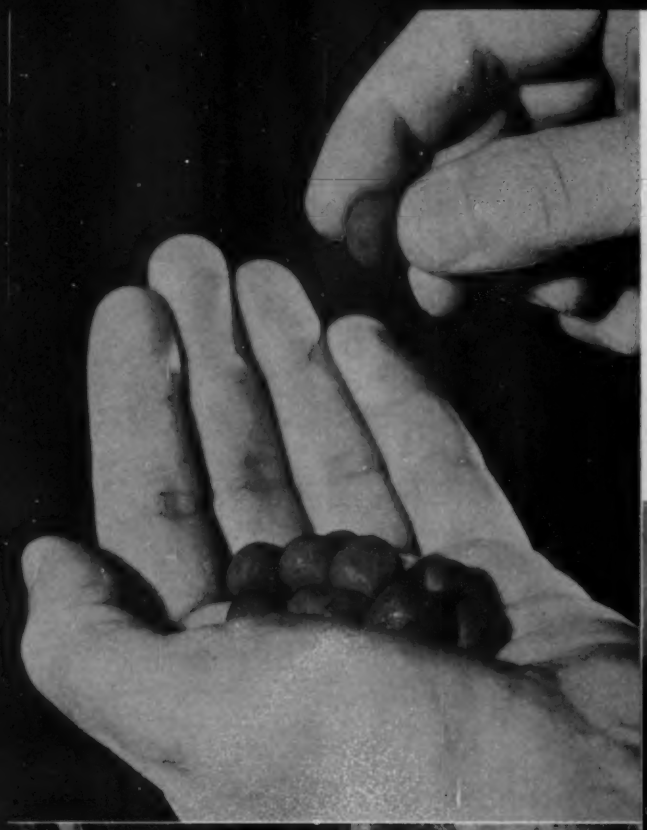
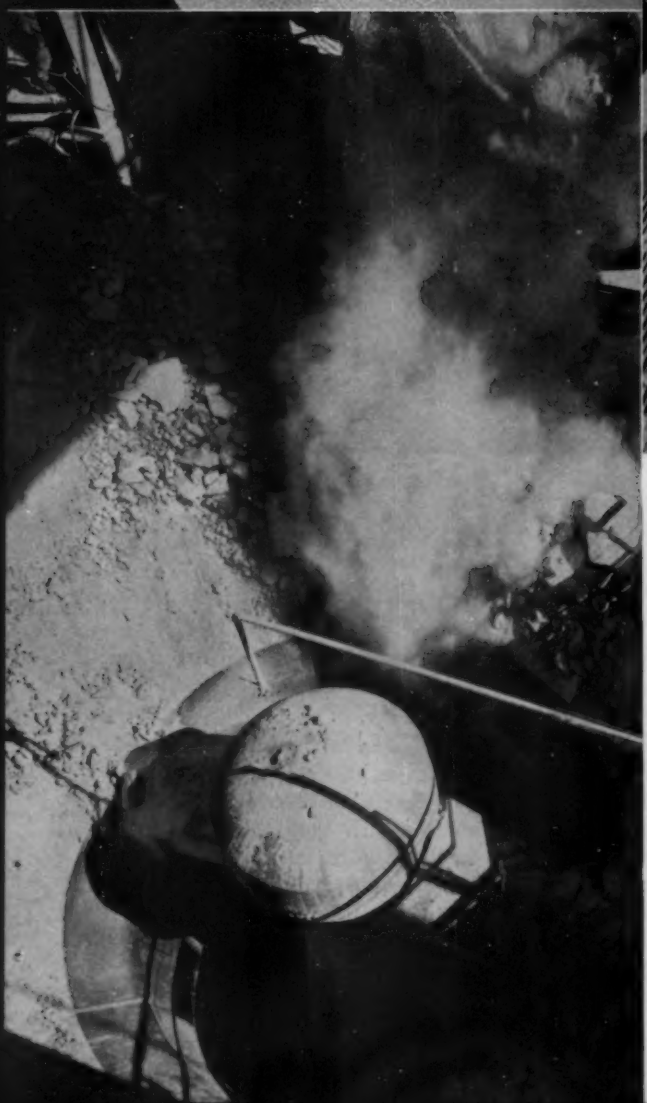


From low-grade ore . . . ideal blast furnace feed: Now processing 1000 itpd of beneficiated, finely powdered concentrates from low-grade iron ore, the new Grate-Kiln system produces these iron-rich pellets. Easy to ship and ready to use as blast furnace charge, these pellets are also economically produced. Costs are kept low by a unique system of heat recovery and process control.

Keeping pellets optimum sized: Installed as part of the first Grate-Kiln system used for iron ore processing, this specially-designed A-C vibrating screen "sizes" pellets from the Allis-Chalmers balling drum, permits only properly sized balls to pass to the system for heat processing. Years of experience in handling screening problems like this have resulted in a wide range of screen sizes and features.



Rugged primary gyratory crusher: This 60-inch Superior gyratory crusher crushes tons of hard, abrasive ores daily — proof of its tough construction. But, in addition, this machine requires no downtime for resetting to compensate for mantle and concave wear. The Hydroset control, exclusive with A-C cone and gyratory crushers, permits instantaneous wear — compensating adjustment while in operation.

A-C INDUSTRIAL EQUIPMENT DIVISION: motors, generators, controls, rectifiers, pumps, compressors, crushers, mills, screens, kilns, coolers, industrial systems.

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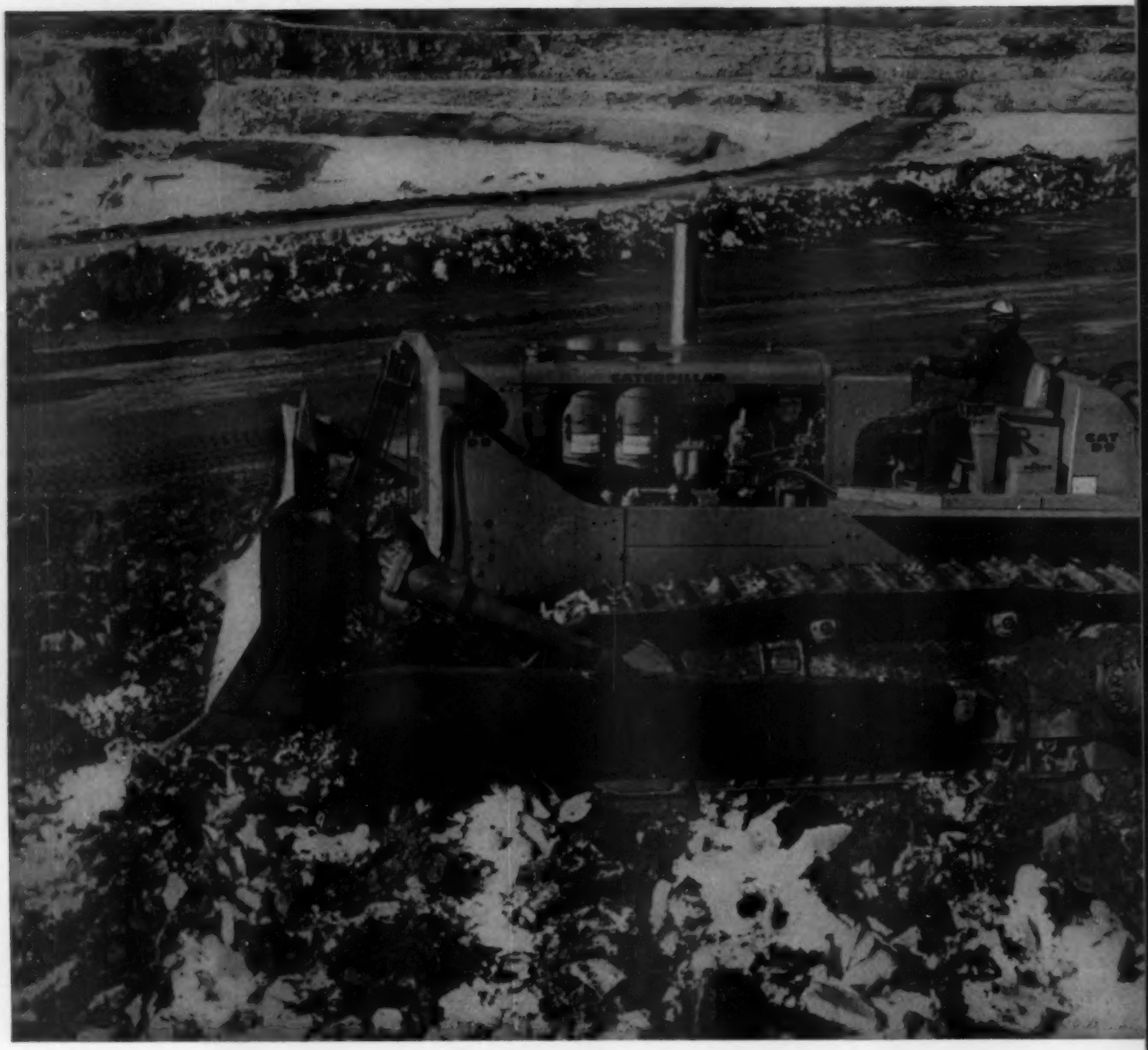

If you're blasting rippable material, your money's going up in smoke

Mining operations are getting quieter. The reason is that more and more owners are replacing expensive blasting of ore and overburden with relatively inexpensive ripping.

The silence will never be complete, of course. Some material is simply not rippable, even with the brute strength of the big Caterpillar D9E Tractor.

But where material *is* rippable, it is considerably cheaper to rip than to drill and blast. Simple arithmetic supplies the most important reason. Add up these costs: power source, compressor, drills, drill bits, labor and supervision for drill and powder crews, dynamite truck, powder and primer, insurance, access roads and benching for drilling equipment.

Then compare the total with the owning and operating cost of a ripping tractor.

And there are other cost-saving advantages in ripping:

1. Ripped pieces of material tend to be smaller than blasted pieces, which means easier, faster handling and increased production. The spacing, depth and direction of ripping passes can be varied to obtain the desired size pieces, eliminating

HOW RIPPING WITH A D9E SOLVED A DIFFICULT AND UNUSUAL MINING PROBLEM

Mining of the main deposit had been completed at a uranium mine—but an excess of 50,000 tons of commercial grade ore still remained in scattered lenticular deposits around the bottom of the pit. They varied in depth from two to six feet, some occupying areas as great as 1000 square feet.

Problem: how to mine them economically.

Blasting would have been uneconomical since the commercial grade ore would have been diluted with surrounding low-grade ore and waste material. Shovel excavation without prior shattering would have been extremely slow, if possible at all.

Engineers suggested trying a tractor-mounted ripper. Tests indicated that this was the answer, and mine supervisors ordered a Caterpillar D9E Tractor with power shift transmission. Attachments included a No. 9 Ripper with two teeth and a No. 9S Bulldozer with tilt cylinder to give added prying action in digging out ore chunks in the more heavily consolidated portions of the formation.

The material is first ripped to a depth of 28 inches on 4-foot centers. Then it is cross-ripped (shown in photo at left) to break the heavily consolidated ore into easily handled pieces for shovel loading. The D9E bulldozes the pieces into a pile for loading into hauling units. Ripping and bulldozing production averages from 300 to 500 cu. yd. per hour. In addition the D9E handles road maintenance.

No other machine is as well suited to this kind of rugged mining work as the D9E. With 335 HP (flywheel) and a massive, long-lived undercarriage, it has the power and stamina to do the job. But, more important, it can do the job at *reasonable cost*. For the D9E's rugged construction and dependable Cat Engine mean that it stays on the job hour after hour, day after day, doing the work you bought it for.

Talk over your ore and overburden removal problems with your Caterpillar Dealer. If it is his best judgment that Cat-built equipment is the answer—he's ready to prove it to you with a demonstration.

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U. S. A.

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expensive and time-consuming secondary blasting.

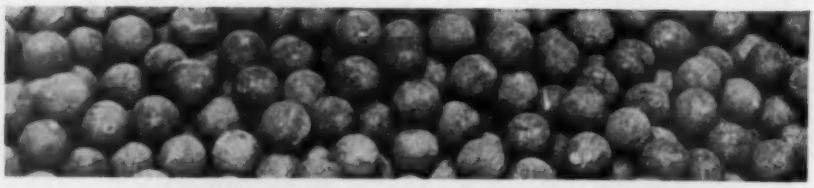
2. Ripping is safer than blasting. And in many cases this can mean lower liability insurance rates.

3. A ripping tractor offers the extra dividend of availability for various bulldozing jobs when it has completed its ripping assignments.

All told, the savings can be quite considerable. In fact, it is a rule of thumb that a ripping tractor used on a production basis can loosen ore and overburden for one-third to one-half the cost of drilling and blasting. In many cases, savings even top that. For example, on the Mesabi Range rock was ripped with D9s for *10% of the cost of drilling and blasting*.

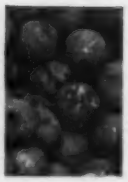
The chart below gives some examples of typical savings. All are actual cases where Caterpillar track-type Tractors with rippers replaced drilling and blasting.

LOCATION	MATERIAL	Ripping Costs (Cents/Cu. Yd.)	Drilling and Blasting Costs (Cents/Cu. Yd.)
Tulsa, Oklahoma	Limestone	7.3	17.3
Dallas, Texas	Limestone	5.2	15.1
San Francisco, Calif.	Sandstone	15.0	30.0
Merriam, Kansas	Sandstone	2.1	11.7
Nelsonville, Ohio	Sandstone	5.7	13.8
Philadelphia, Pa.	Limestone	11.5	19.3
Carbo, Virginia	Sandstone	8.6	15.7
Hibbing, Minn.	Frost	25.0	60.0
Hibbing, Minn.	Paint Rock	6.1	54.5

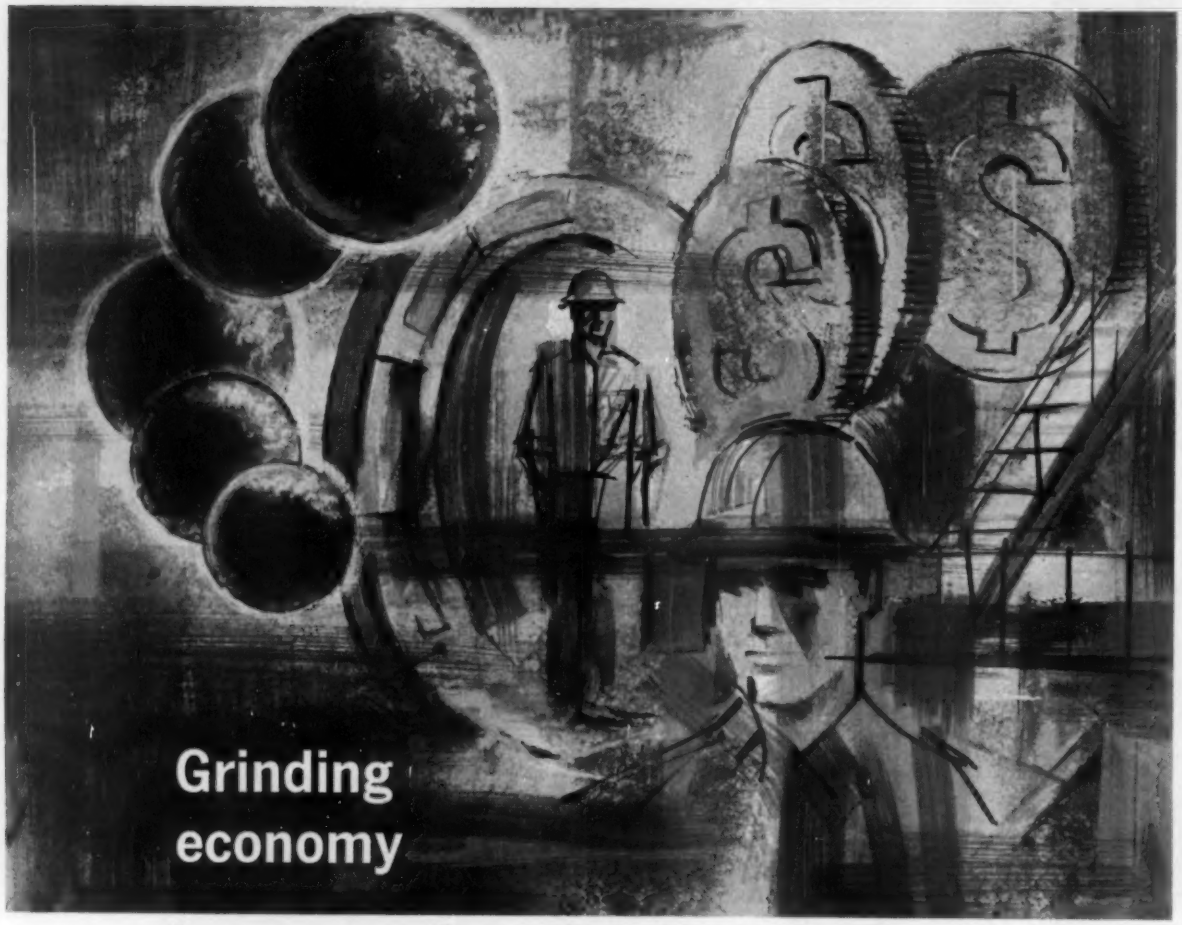


Strong
Tough
Economical
Efficient
Lasting

Steel



SHEFFIELD MOLY-COP Grinding Balls



has earned customer acceptance

Over a million tons of Sheffield Grinding Balls have proved that Moly-Cop quality will give you better grinding at lower cost. What's behind this fine performance? Hardness, toughness and uniformity. Hardness to fight wear. Toughness to resist spalling and breaking. And uniformity of fine grain structure right to the core. That's why Moly-Cops keep their spherical shape longer, require fewer chargings and less down time, and save you money in the long run. **Sheffield Plants: Houston, Kansas City, Tulsa.**

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MINING engineering **DRIFT**

OUR ROLE IN A CHALLENGING DECADE

Editor's Note: *It is particularly appropriate that, in this issue of* MINING ENGINEERING, *the new President of the Society of Mining Engineers, Mr. J. C. Gray, submits his greetings to all members, and in so doing, reminding us of our responsibility in developing the mineral industry to meet the demands of the 1960's. It is with pleasure that we welcome President Gray to his new responsibility in guiding SME during the year ahead.*

Dear Fellow Members of the Society of Mining Engineers of AIME:

I should like to express my appreciation to all of you for the honor of serving as President of our Society during the coming year. It is my aim to promote and maintain the interest and purpose of our Society in developing our technology in the mining and use of mineral resources for the broad interests of our national and international welfare.

We are now in the second year of the so-called promising decade of the 1960's with one year of hindsight to assist our appraisal of just how promising it will be. How well have we kept informed of what is happening in this wider, broader, faster-moving, ever-changing world? What has been the significance of these changes to our mining profession? What are the demands on our profession to satisfy the requirements of population growth, higher living standards, space age requirements, nuclear power developments? We are all searching for the right answers to these questions and, as engineers of the mining profession, we have a responsibility to see that we do not fail to meet any and all requirements as they develop.

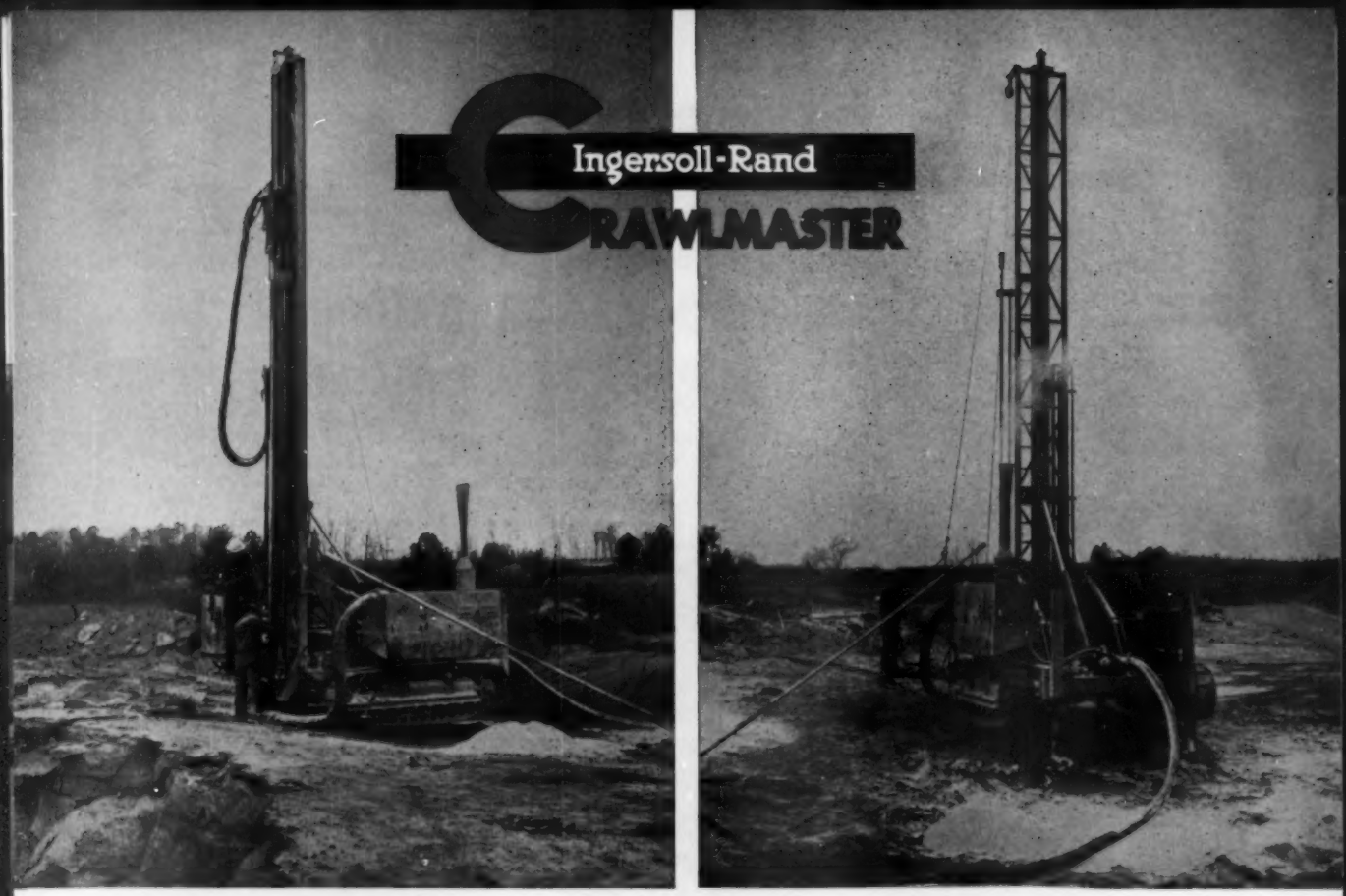
Our Society has been outstanding in the past in serving our profession to meet all economic requirements. It has always been gratifying to witness the untiring efforts of our members and to be proud of their accomplishments. The task ahead becomes more diverse, more complicated, and certainly more demanding. The purpose of our Society is accentuated by the needs of the "promising Sixties."

The response to my requests of our members to serve on the many and varied committees in our constitutional make-up has been a real revelation to me of "what makes us tick." With their able assistance, I am looking forward to a good year for SME.

Very truly yours,

J. C. Gray

J. C. Gray
1961 President
Society of Mining Engineers of AIME



NEW heavy-duty crawler drill

MOST RUGGED—tons of sound design
MOST POWERFUL—outperforms 5½" drills
MOST VERSATILE—4" to 6½" holes, vertical to horizontal

The new Ingersoll-Rand Crawlmaster is a *multi-purpose machine* that meets every requirement for percussion, rotary or Downhole drilling of 4" to 6½" blast holes in any type of ground. Here are just a few of its outstanding features:

Constant-Pressure, Double-Acting Hydraulic Feed—smooth, infinitely-variable power for drilling pressure or pulling stuck steels. Drill won't jump ahead in pockets or fissures.

Simple Hydraulic Control Of All Tower Positions. Tilting of tower on yoke and raising or lowering of yoke hydraulically powered by separate cylinders. All throttles outfront for easy operation.

Throttle-Controlled Reverse Rotation permits fast uncoupling of steels without having to climb tower to reverse drill.

Ejector-Type Dust Collector has no moving parts to wear out or maintain. A simple air-jet does all the work.

Heavier—Extra weight is reflected in sound design assuring extra stamina for the toughest drilling jobs. Has rugged, tractor-type crawlers with enclosed gear drive.

Four 30" Stroke Hydraulic Leveling Jacks permit accurate tower positioning with maximum stability on rough terrain.

Hoist, Rod-Changer And Hydraulic Wrench greatly simplify addition or removal of steel sections.

Interchangeable drills and rotation units permit one machine to be used for percussion, rotary or Downhole drilling of 4" to 6½" holes, taking power from a 600 or 900 cfm portable compressor. For a new high in drilling speed and economy, ask your I-R engineer for the Drillmaster story. Or send for Bulletin 4211.

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A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK

USE OF PRESSURE GROUTING TO STABILIZE GROUND IN THE SAN MANUEL MINE

A survey of literature published in the U.S. on grouting indicates that most such work has been done to stop water flow in mines and for stabilizing foundations of various man-made structures. Apparently San Manuel is one of the first mines in this country to use grout extensively underground for the strengthening and stabilizing of ground about drifts, shafts, and stations.

by J. W. GOSS and M. J. COOLBAUGH

The employment of pressure grouting as a ground stabilizer at the San Manuel Copper Corp. mine reduces delays in both development and production, lowers costs, and makes possible safer working conditions. It specifically reduces delays in haulage operations and permits the maintenance of normal ventilation. In development work this grouting allows faster excavation by cementing together highly fractured or broken ground that otherwise would require extensive cribbing or spiling. In drift repair, it consolidates the loose or fractured rock over the timber or steel drift supports, thus decreasing the frequency of repair, lessening the hazards from falling rock, and curtailing delays due to blockage of drifts by muckpiles and repair operations.

Pressure grouting is the process of pumping an accurately controlled mixture of cement and water into loose, fractured, or porous rock. The ratio of water to cement varies according to the nature of the rock encountered, from the thinnest mixture of 30 gal of water per sack of cement, used to fill very fine fissures, to very thick grout of 5 gal of water per sack of cement, used to fill large fissures or extensive areas of loose, broken rock. The pumping pressures at San Manuel vary from about 100 psi to 1000 psi, depending upon the compactness of the rock, while at other mines the pressures sometimes go as high as 5000 psi. In order to grout an area in which ground water is encountered, the pumping pressure of the grout must be increased by an amount equal to the pressure of the ground water.

J. W. GOSS, Member AIME, formerly Research Engineer and presently Contract Engineer of San Manuel Copper Corp. M. J. COOLBAUGH, Member AIME, is Research Engineer, San Manuel Copper Corp., San Manuel, Ariz.

GROUTING IN DEVELOPMENT WORK

The areas under development at San Manuel include many sections of loose, highly fractured rock. Prior to the advent of the grouting program, drifts, shafts, and stations in these areas could not be excavated without utilizing extensive support such as cribbing, spiling, and breast boarding. This slowed down the development work and increased the costs considerably over that required for excavating in more competent ground. Now, when a particularly bad area is contacted the mining is temporarily stopped while the bad portion of drift or shaft is grouted. After the grouting is completed the excavating is resumed with an approximate decrease of 50 pct in lost time and costs.

Grouting in Drifts and Turnouts: The grouting procedures and patterns used in drifts and turnouts are very similar. The standard procedure for grouting such a turnout is shown in Fig. 1. After the ground is supported as well as possible with cribbing or lagging, the gaps between the back lagging

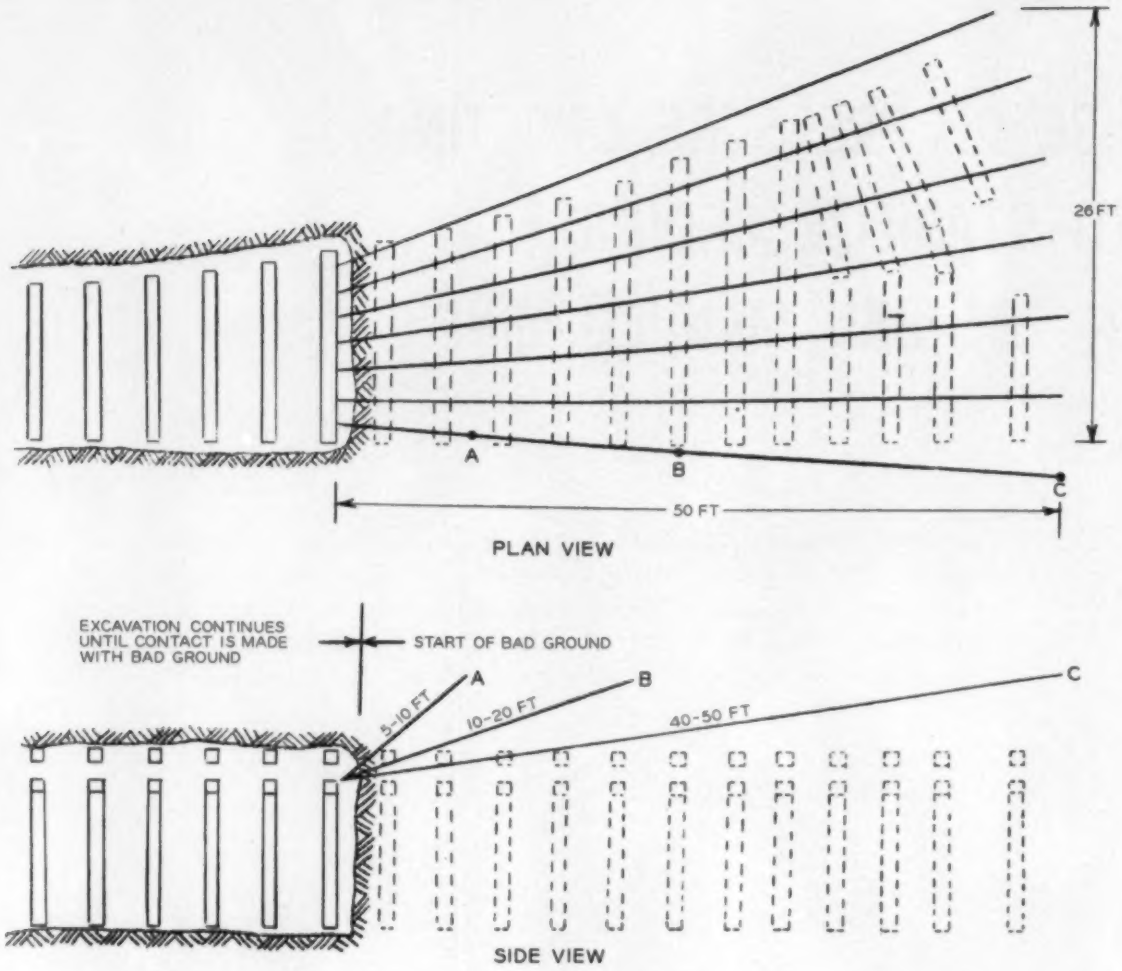

Fig. 1—Grouting pattern for a drift turnout.

and side lagging are plugged with empty cement sacks or additional timber, if necessary. The ground surrounding the proposed turnout is then grouted in two stages.

In the first stage, the broken and caved rock is drilled and grouted to a depth of 5 to 10 ft, depending on the depth of the broken rock. This stage forms a grouted seal that allows higher pressures to be used at depths beyond 10 ft without developing excessive leaks at the face. After a grout hole is drilled, a 10-ft long pipe is wedged tightly into it with empty cement sacks. Grout is then pumped into the hole until the pressure reaches 200 to 300 psi, and the pipe is subsequently removed if it hasn't become cemented in. No more than one hole at a time is drilled and grouted because the grout has a tendency to go from one hole into another, plugging up the latter. Five or six holes are usually adequate for the first 10 ft of grouting. Experience has shown bentonite to be a useful admixture to the grout, particularly when it is indicated that the grout is being "lost" into large fissures or voids. Bentonite increases the plasticity of the grout, enabling it to remain in place more easily until it has begun to set.

In the second stage, the longer holes are drilled through the previously grouted rock, after which the same grouting procedure as in the first stage is repeated. The pressure is allowed to build up to approximately 500 psi—the capacity of a single grout pump. If higher pressure is desired due to less permeable ground, two pumps are connected in series to increase pressures to 800 psi to 1000 psi. In this latter case, however, additional preparation of the holes is necessary: larger diameter holes 5 to 7 ft deep are drilled; then 2-in. diam collar pipes are placed in the holes and anchored with grout so that they won't blow out or leak under the high pressure. The hole is then re-drilled through the pipe to the desired depth. The use of 800-1000 psi instead of 500 psi for pumping has increased penetration by about 30 pct, subsequently increasing the amount of cement placed from approximately eight sacks per hole to more than eleven sacks per hole. After all holes are grouted, excavating proceeds as usual, using reasonable care during blasting.

The average time required to grout and excavate a turnout such as this is approximately 14 days (three shifts per day). In contrast, the average time expended in excavating a turnout with equally bad ground without resorting to grouting has been approximately 21 days.

Not only does grouting increase drifting rates through bad ground in turnouts, but it performs

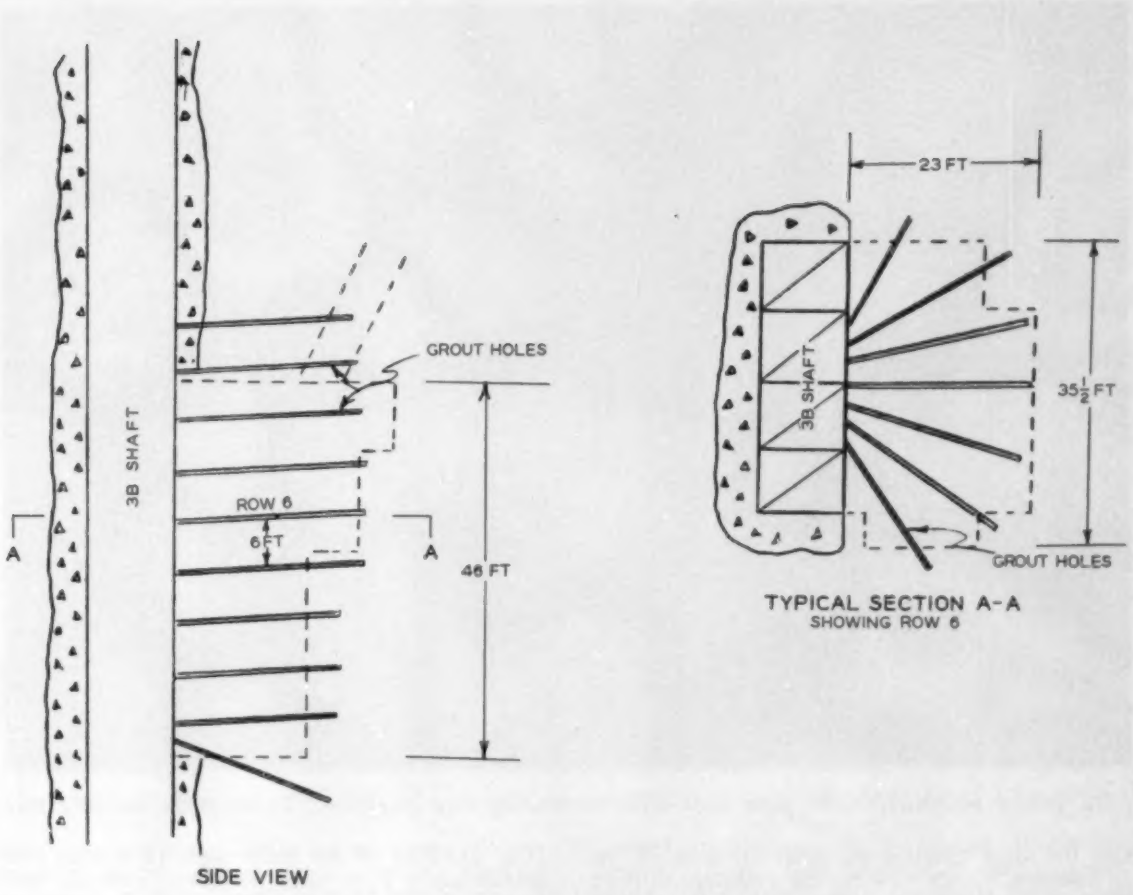

Fig. 2—Pre-excavation grout pattern for loading station on 2075 level.

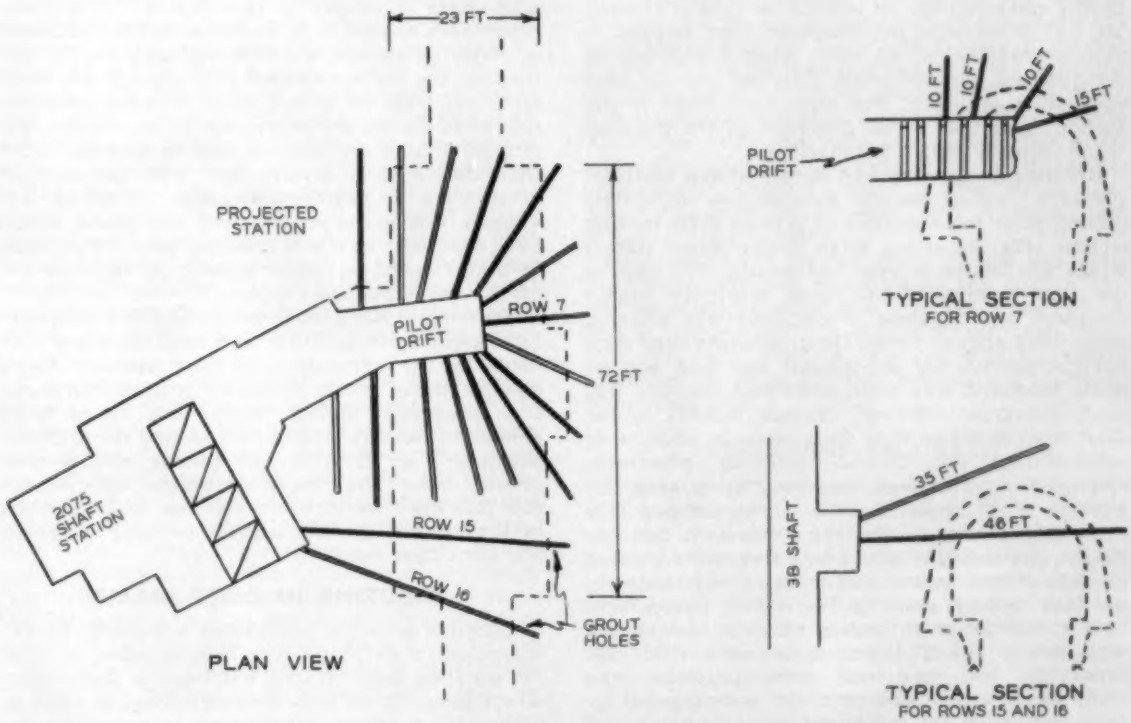

Fig. 3—Pre-excavation grout pattern for rotary dump station on 2075 level.

Loose ground consolidated with grout (dark areas surrounding rock fragments). Pocket knife indicates size.

also the same function in regular drift work. As an example, a drift crew driving a haulage drift on the 2075 level encountered a section of decomposed rock intensely fractured by fault movement. At first they attempted to continue mining with the use of spiling and cribbing, but after three days of averaging 0.21 ft advance per manshift, they stopped to permit grouting of the area. After completion of the grouting, the drift crew returned and resumed excavating at nearly the same rate (0.82 ft per manshift) as that which prevailed in the previous "good" ground (0.92 ft per manshift).

Grouting in Loading and Rotary Dump Stations: Pressure grouting has also been used to consolidate ground prior to excavation of a large shaft loading station (Fig. 2) and a large rotary dump station which are located in very bad ground. The rock in the shaft loading station area was very highly fractured and in loose blocks, and was yielding about 1300 gpm of water. Grout pressure used here did not exceed 500 psi because the rock was so badly fractured that when additional pressure was used, the grout returned through fissures to the shaft from as far as 30 or 40 ft away. In addition to consolidating the ground, grouting effectively stopped the water flow into the station area. An average of 15 sacks of cement was pumped into each hole. Later, during the excavation for this station, the solidified grout was frequently evident in large gaping fissures and seams, clearly suggesting that without grouting the station would have been completed only through extended delays and with serious risk of injury to the men. After the excavating and concreting were completed, the walls were further stabilized and waterproofed by drilling through the reinforced concrete lining and regrouting. Similar to the earlier drilling pattern (Fig. 2), most of the holes were 10 ft long and fanned out in a series of horizontal rows six feet apart.

Fig. 3 shows the drilling pattern used for the large rotary dump station. The rock was very soft with many streamers of clay and silt. The grout pipes were cemented in and two pumps connected in series to achieve the 1000-psi pressure. In this instance the average cement consumption was eight sacks per hole. No ground runs or caves were encountered during the excavation of this station; the grouted ground was firm and easy to mine. As in the shaft station, large fissures filled with the solidified grout were frequently noticeable, indicating that without this grout considerable overbreak would have resulted. The use of grouting here also resulted in a corresponding lesser amount of concrete required for permanent support.

Grouting in Raise Stations: In addition to speeding development in drifts and stations, grout also helps in the excavation of raise stations above haulage drifts where frequent ground movement and subsequent timber repair have left a large amount of loose or broken rock around the drift excavation (Fig. 4). This surrounding area is now grouted before the excavation begins, with the result that the raise station crews can drill and blast in the grouted ground without creating excessive and hazardous overbreak.

GROUTING IN DRIFT REPAIR

Although grouting contributes materially to development work at the San Manuel mine, most of the grouting work to date has been in drift repair where grouting methods were developed in order to relieve the problems attributable to weak, moving ground. The very process of caving and drawing

The cement car; pump car with grout pump, mixing tanks, and grout pipe; and drill jumbo employed at San Manuel.

columns of ore from beneath the extremely cohesive mass of overlying waste rock produces extreme pressures on the adjacent uncaved ore, causing it to compress and undergo plastic deformation. It responds somewhat as clay would, maintaining its structure while slowly pressing into the stopes and down upon the haulage drifts below*. It cannot be contained above the haulage drift for very long by either timber or steel supports. After the timber supports have been changed several times, considerable arching occurs in the ore above, which with further ground movement crumbles into the form of broken rock on top of the timber sets, making further timber repair difficult and hazardous. At times this broken rock gets out of control during the process of timber repair and spills into the drift below, blocking the movement of ore trains and restricting ventilation. Grouting this broken material not only reduces the frequency of repair and retards ground movement, but also makes the repair easier and safer.

The ground is consolidated in two 10-ft stages, producing 20 ft of grouted rock above the drift. In the first stage two 10-ft holes are drilled into the back of the drift through the backlagging at an angle of approximately 22° from the vertical, as shown in Fig. 5. These holes alternate every five feet along the drift with a single vertical 10-ft hole. In the second stage this grouted area is re-drilled and re-grouted with 20-ft holes in the same pattern, providing the full twenty feet of grouted rock. Drilling this ground with 20-ft holes in just one stage was tried, but the loose ground made it so difficult to keep these holes open long enough to get the pipe in that this method was discontinued. Grout is pumped into the hole until the ground will not take any more, until a leak develops, or until it is suspected that a large void is needlessly being filled. As before, only one hole at a time is drilled and grouted. Occasionally grout will not enter the rock with the pipe inserted all the way into the hole; in this case the pipe is withdrawn 2 ft and the grout again forced into the hole. This process of moving the pipe out of the hole two feet at a time and then pumping grout continues until either the grout enters the broken ground or the pipe is completely withdrawn from the hole. As a rule, the grout penetrates effectively over a 5 to 10-ft radius, producing an effective overlay of consolidated rock. A two-man crew will average about five linear feet of drift grouted per shift.

Grouting of the back of the drift has also been tried in some heavy areas where the ground exhibited plastic flowage but was not fractured or broken. Here grout was unable to penetrate, and, thus was not effective. Use of higher-pressure equipment to penetrate the more compact rock is being considered.

EQUIPMENT AND CREW

The grouting program operates only when required, with the number of crews usually varying between two and six. The crews are ordinarily placed on a three-shift basis so that grouting can be conducted continuously. Each grout crew is equipped with a drill jumbo, mixing tank, cement receiving trough, and a grout pump. All units are track-mounted to allow the maximum flexibility of movement underground.

Drilling is done with three-inch drifters on one-boom jumbos, using 5-ft lengths of ⅞-in hexagonal steel and throw-away bits. Collar pipe holes have

* For further information on the San Manuel mine see: J. F. Buchanan and F. H. Buchella: History and Development of the San Manuel Mine, *AIME Trans.*, 1960, vol. 217, p. 394.

2 ⅜-in. diam; regular grouting holes have 1⅞ to 1½-in. diam.

The cement, delivered on flat cars holding two pallets of 30 sacks each, is loaded on the pallets at the cement company and is not handled by hand again until it is dumped into the mixing tank at the grout pump. Our cement consumption averages approximately 22 sacks per crew-shift in station and turnout development, and approximately 63 sacks per crew-shift in drift repair.

The cement is mixed in a 50-gal capacity tank which is fitted with a rotating agitator paddle. Compressed air supplies the power for the motor which drives the paddle.

After the cement is mixed, it discharges through a 4-in. diam pipe into the 50-gal receiving trough or tank which, in turn, discharges into the grout pump. The trough allows continuous operation by providing temporary storage for the grout while another batch is being mixed, and it provides a place where pieces of hardened cement can be removed from the mixed grout before they can get into the pump. If trouble develops requiring much delay while there is grout in the tank or trough, the grout is either pumped or shoveled out of the trough into any available space behind the drift side lagging.

The 6 x 2½ x 6-in. grout pumps which are now used in the operation were modified so that each pump can handle approximately 14 gpm of grout solution while maintaining an average output pressure of 500 psi. These pumps are used either singly or in series, depending on the pressure required for the work being done.

COMPARISON OF GROUTING AND CONCRETING

The grouting program complements the extensive concreting program employed at San Manuel. In both development and in bad ground, grouting is used as an aid for excavating, whereas concrete is used for permanent support after excavation is complete. In drift repair, grouting becomes an actual repair medium and also reduces ground movement by consolidating broken ground to give it more structural strength. Concrete, on the other hand, is used to hold ground which is too heavy for support by grout and timber. If ground weight is exceptionally heavy, grout is also used *after* the drifts are concreted to further consolidate the rock and reduce ground movement.†

Table I compares the costs and life of support of concrete, grouted ground, and timber. The comparison of these differing methods was made in the same drift with the same extremely heavy ground conditions prevailing for all three. All ground in this drift is now supported with either timber and grout or with concrete. Some drifts require only occasional timber replacement; however, many require the additional support provided by grout or concrete. When determining whether timber, grout, or concrete will be used to repair the timbered drifts, the main factors which must be considered are the length of time that the drift must remain

Table I. Comparison of Repair Costs and Life of Support in Haulage Drifts Subjected to Extreme Ground Pressures

	Estimated Support Life (in months)	Repair Costs[1]
Timbered drifts repaired with:		
Steel sets and concrete	24	$80[2]
Grout	5	$50[3]
Timber	1.5	$40[4]

[1] These costs are to repair a portion of drift one time.
[2] This cost includes complete removal of all old timber and replacement with steel sets and concrete.
[3] This cost is with the use of two-stage grouting.
[4] This cost is for a complete change of timber, including posts, cap, back and side lagging.

† For further information on concreting at San Manuel mine see: C. L. Pillar: The Placement and Use of Concrete Underground, *Min. Cong. Jour.*, Sept. 1960, and M. H. Ward: Underground Concreting at the San Manuel Mine, *AIME Meeting*, Tucson, Ariz., December 1958.

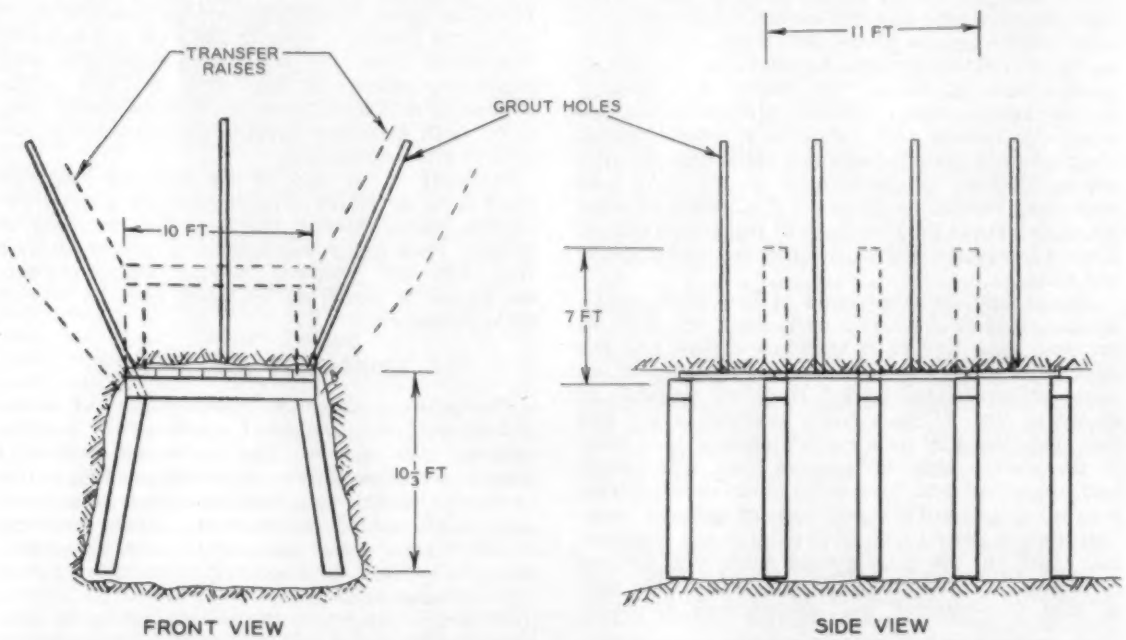

Fig. 4—Grouting for transfer raise station in haulage drifts.

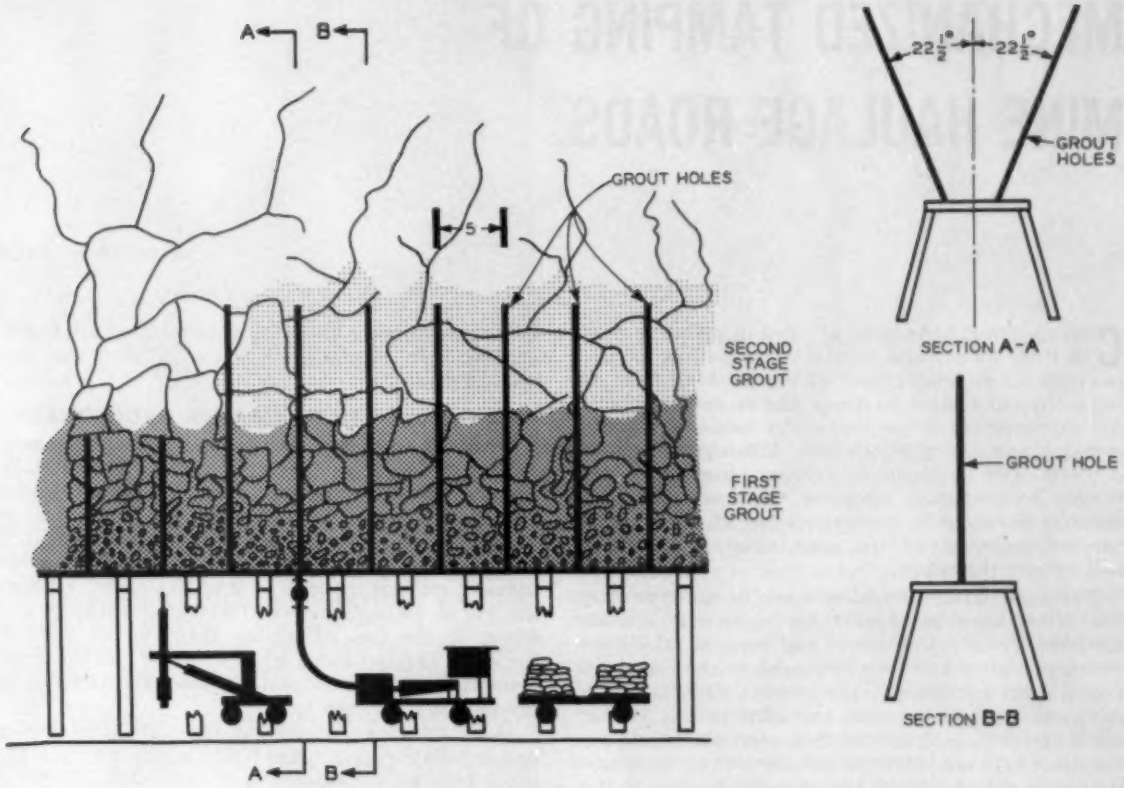

Fig. 5—Grouting to stabilize ground in heavy, weak areas on haulage levels.

open for ore transportation; severity of the ground weight; and the ability of the ground to take grout. The most economical type of repair is the one with the lowest initial cost which will last without being replaced for the remaining useful life of the drift. While grouted haulage drifts do not have as long a support life as concreted drifts in the heavier ground, in most cases the grouted drifts hold up as long as needed and therefore they are more economical to use than the concreted ones. When compared with concreting, grouting also saves time because drifts can be repaired faster with grout since no forms or supports are necessary and no removal of loose rock above the sets is required; and drifts undergoing grouting can be kept open for production during the grouting period since they are not blocked by either forms or supports.

Concrete, on the other hand, being made with better aggregate, provides stronger support over a longer period of time; it can also be placed in ground that will become heavy but is too compact or uniform to take grout initially.

The reduction in repair costs on the haulage level since grouting was introduced is appreciable. Using the 1475 level haulage drift as an example, the maintenance cost per ton of ore produced has been lowered from about 7¢ in 1957 (when experimental grouting began) and a high of 18¢ in 1959 (when grouting was first employed on a full-time basis) to 4¢ in the latter half of 1960. Although other factors such as concreting, more efficient timber repair procedures, and some reduction in ground weight on the haulage level contributed to the overall decrease of these repair costs, a major portion of these savings can be attributed to the use of grout.

SUMMARY

Because concrete instead of timber is now being placed initially in areas which are expected to take weight in the future, the need for grouting in repair work is diminishing. On the other hand, grout is being used more frequently as an aid for development excavation, with new applications continually arising, such as grouting ahead into loose areas located by diamond drilling, and possibly using grout as a roof support alone or with rock bolts. With the use of higher pressures we can foresee an even broader range of application, primarily in stabilizing highly fractured, but more compact, rock. Thus, not only does grout occupy an important place in mining at San Manuel now, but it promises to be even more useful, particularly in development areas, in the years to come.

ACKNOWLEDGMENT

Acknowledgment is due Mr. H. Richards, Engineer, and Mr. R. Blonigan, Secretary, for preparation of graphs, charts, drawings and pictures. Considerable assistance and technical information was also obtained from Mr. R. Noseck, Contractor for grouting at San Manuel.

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MECHANIZED TAMPING OF MINE HAULAGE ROADS

by DAVID H. DAVIS

Coal operators have been justified in spending most of their efforts and capital expenditures on improvements in productivity at the working face, on better transportation facilities, and on surface plants for improvement of the product by means of modern cleaning and drying equipment. Although the above subjects will continue to receive close study for further technological advances, there are other operations involved in the production of coal, which can be improved by the application of ingenuity and modern equipment.

Underground construction work of all types has too often been performed by inefficient manual methods. Treated ties, heavy rail sections, and good rail-splicing methods are employed in the construction of main line track at many mines, but quite often adequate ballasting is not included in the job. If stone ballast is used as filler between the ties and for the space between the track and the side of the entry, it often is not effectively forced under the ties to the proper depth. One of the reasons that ballasting has not received as much attention as other phases of track construction in mines is that well-aligned heavy rail on good ties will usually make a reasonably good track over which cars can travel at high speed. However, after a few years of intensive use, particularly where grades are steep, the rails become twisted or surface bent and all too frequently there will be broken rails. Most of this occurs because the initial blocking under the ties has rotted out and, since the permanent ballast had not been forced under the ties, the track shifts and the rail joints drop.

The first step in the construction of a good road bed for track haulage is to provide the means whereby an adequate supply of ballast may be delivered at low cost to the point where needed. At Mathies mine near Finleyville, Pa., this first step was taken about 15 years ago when a 20-in. diam bore-hole 60 ft in depth was sunk, and a 40-ton capacity storage bin constructed on the surface to hold 1x2½-in. screened blast furnace slag for use as ballast. The bore-hole was located on the center line of a track entry, and the bottom of the pipe was equipped with an undercut gate which could be manually operated to load ballast cars. At first, ballast cars of three to five-ton capacity were used and various schemes devised for controlling the discharge of ballast through gates in the bottom of the car. As the distance from the ballast bore-hole to the new track-laying area increased to several miles, it became evident that large capacity ballast cars were required to reduce the cost of ballast delivery. Four twenty-ton capacity cars, each with four separately operated hinged gates, were built. These cars have been highly successful in reducing the cost of hauling and distributing ballast.

NORMAL TRACK LAYING PROCEDURE

After the entry has been cleaned and, if necessary, graded to the proper elevation, ties are laid on 24-in. centers, the rails are spiked to the proper gauge, and blocks laid under the ties to bring the rail to a pre-determined elevation. The rail alignment is made during this operation and proper spacing left between ends of the rails in preparation for welding the joints. Ballast is then distributed between and alongside the ties, filling the space to the level of the rails. The rail joints are then made and the track is ready for final alignment, leveling, and tamping of the ballast under the ties.

Many mines are rushed to complete their heavy rail installations and often traffic is moving over the track before final ballasting is completed. Where it has been possible to complete the entire project and do a first-class job of ballasting and tamping before traffic starts, the rail maintains its level and alignment to a much greater degree than if traffic starts before this is done. There are many different standards of ballasting and few mines have gone to the expense of forcing ballast completely under the ties directly under the rails. At Mathies, where there are two independent haulage roads each ten miles long and each handling single direction traffic, the ballasting, leveling, alignment, and tamping operation has been carried out carefully.

MECHANICAL TAMPER EMPLOYED AT MATHIES MINE

For several years the track alignment and tamping crew at the Mathies mine consisted of five men—one man handling the lift jacks used in leveling and aligning the rails, and four other men, each operating a hand-held pneumatic tamper. These men forced the slag ballast under the ties until the space under the rails was densely packed but leaving the ballast loose toward the center of the ties. Since some pieces of slag were up to 2½-in. diam, the tamping operation was laborious and time-consuming. However, management was interested in obtaining a good haulage road for high tonnage and long life. As the amount of track work increased along with the continued rise in wages, it was desirable to maintain the high standard of track construction yet reducing the cost of ballasting. Unless some machinery could be developed, it would become necessary to add an additional crew.

For several years, the mechanization of railway track construction had been noted and the Mathies officials were particularly impressed by mechanized ballast tampers. It was determined that the tamping head used on the railroad tamping equipment could

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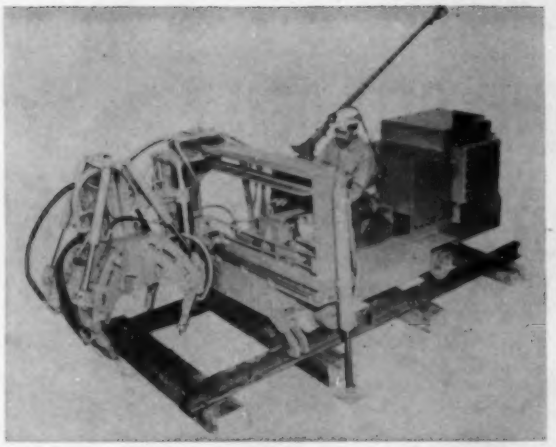

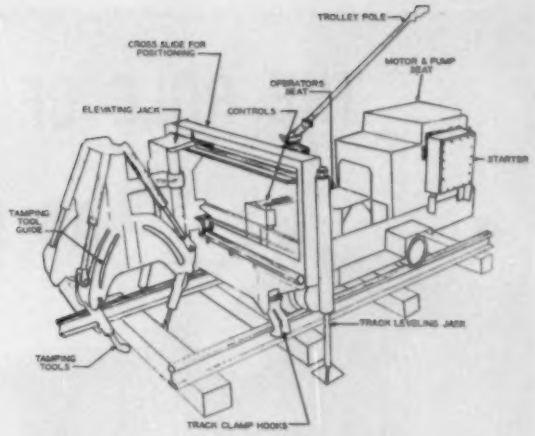

The track tamper employed at Mathies mine and a diagram of its component parts.

be adapted to coal mine track construction. The tamping equipment of two railroad equipment manufacturers was studied; in one instance the vibration was obtained by electrical impulses and in the other, by pneumatic hammers. The interest of a manufacturer of coal mining equipment was enlisted which resulted in the development of the mechanized tie tamper.

The accompanying diagram shows the Fletcher Track Tamper Model-TTA. It consists of a self-propelled truck, plus a cross-slide to hold and position the tamping tools. In addition there are two track leveling jacks and two track clamp hooks, actuated by hydraulic pressure. The tamping tools are actuated by air but their positioning is done hydraulically through the elevating jack and cross-slide. All controls are centrally located so that the entire operation is under the control of one operator. In railway usage the air compressor is mounted on the same frame and truck as the tamping mechanism, but due to limitations of space imposed on a mine unit, it was believed best (at least on the first unit) to handle the compressor as a separate unit which can be located in a separate truck adjacent to the tamper.

Pertinent operative information of the tampers is as follows:

- 1400 strokes per minute.
- 11½ ft-lbs per blow.
- Four hammers per machine, two on each side of tie.
- 125 cfm of air required at 85 psi.
- Line lubricators are used for oiling the guns.
- Can tamp any raise from zero to maximum.
- Tampers will penetrate 2¼ in. below a 6-in. tie used with 85-lb rail.
- First insertion of tamping tools forces tie up to base of rail, in case it is not spiked. Additional insertions feeding and compacting stone into the void.

The machine is used on new track where the hydraulic track-leveling jack and rail clamps are extremely useful in bringing the new rail to the proper elevation, but it can also be used as a spot tamper. It has been used to repair old track—particularly in tamping under joints, low spots, and switch frogs. By shifting the head, either end of the tie can be tamped. The tamper is designed to effectively tamp ties of normal spacing of 22 in. or may be used with spacing as low as 19 in. and with one set of guns to 15 in.

Great usefulness can be derived from this type of machine in the reconditioning of road bed and track that have been in service for a number of years. Low spots or swags can be readily raised to proper elevation by distributing new slag between the rails and the top of the ties. Then by using the rail clamps, the rail and ties can be raised to the desired elevation and immediately tamped. This can be repeated if necessary. By using two men and a machine on a non-operating day, several hundred feet of track can be reconditioned at low cost.

SUMMARY

The results achieved by mechanized tamping have been gratifying. A performance study was made on an installation of new 85-lb track with 6x8-in. creosote ties spaced on 24-in. centers with slag ballast averaging 8 to 10-in. deep under the ties. Two men, the operator and his helper, tamped 209 ties (418 ft of track) in 263.36 min, or 1.26 min per tie.

The following is a break-down of a shift's work time of 6.75 hours:

	Minutes
Oil machine	6.95
Set jacks and align track three times	91.29
Take loose roof down	18.40
Tamping time for 209 ties	263.36
Hydraulic jack struck	4.71
Miscellaneous	9.51
Out of slag	11.00
Total minutes	405.22

Mine officials believe that a better performance is possible than that indicated above. Formerly, five men aligned and tamped 100 ft per shift while two men with the tamper aligned and tamped 418 ft per shift. The improvement is from 20 ft per man-shift to 209 ft per man-shift. Working under the same conditions and performing the same type of a job, these figures are a fair appraisal of the value of a mechanized tamping. By adding a third man to the crew to eliminate the necessity for stopping the machine to help align and jack the track in place, 144 additional feet could be tamped per shift; but this would reduce the footage per man.

This is but one example of what the coal mining industry has to gain by devising new and better ways to accomplish the various construction jobs that are a necessary part of coal mining operations.

THE ROLE OF THE GEOLOGIST AT BUTTE

by

EDWARD P. SHEA

The Anaconda Co.'s Geological Department at Butte, Mont., was started early in the Company's history because of litigation involving vein ownership and extralateral rights. The problems, some of which were resolved in courts, were many because of the large number of veins and lode locations. Defensive action was required to prove ownership and protect against illegal exploitation of the downward and extra-lateral extensions of the ore bodies. In many cases it was necessary to define the outcrop of the vein and to show that its apex was within the boundaries of the lode claim. Exhibits illustrating geology were needed to present the cases clearly, and these could be made only after careful inspection and mapping of the underground workings by competent geologists. Also, The Anaconda Co. was one of the first companies to recognize the worth of skilled mining geologists and the value of accurate records in the search for new ore. The department was organized in 1900 by H. V. Winchell who, with D. W. Brunton, worked out the methods. Reno Sales was Chief Geologist from 1906 until 1948 when he was succeeded by V. D. Perry, the present Chief Geologist. Under their direction, F. A. Linforth, M. H. Gidel, C. H. Steele, E. P. Shea, C. C. Goddard, Jr., and W. A. O'Brien enlarged the scope of the work and improved the technique.

Many men have been required through the years to map and record the geology because of the magnitude of the district and the number of mines. Fortunately, the mine geological mapping was standardized at the start of this program and now a complete, uniform record has been accumulated.

The geologist at Butte works closely with the mine operators, and his job is not finished until the ore is discovered, developed, and mined. He keeps a close inventory of reserves which with the geologic record, enables him to plan intelligently the development and mining. Important projects inaugurated during the past years were adopted only after a careful study of the geologists' records.

The Geological Department is a service unit cooperating with the other departments to produce metal with minimum costs. In addition, the department is involved in all development projects including such items as ventilation, drainage, and haulage. The duties of the geologist, mining engineer, sampler, and assayer are closely related and coordinated by the Chief Geologist—Montana Operations. Directly under this man is the Chief Geologist—Butte Operations, Chief Mining Engineer, Chief Sampler, and Chief Assayer.

The Chief Geologist—Butte Operations is responsible for the geologic and sampling work in Butte and is assisted by one Mines Geologist. Beneath the Mines Geologist are the geologists and assistant geologists. Each mine uses one geologist and the larger mines employ the services of an assistant. The geologist is responsible for the development, mapping, and ore estimates at his mine. The Chief Sampler supervises the sampling, and for this work one senior sampler and several regular samplers are used at each mine. The samples are assayed in a central office under the Chief Assayer's direction.

MAPPING METHODS

New men starting with The Anaconda Co. are tutored by older geologists until their mapping is standardized. The relative strength of the geologic structures is depicted by the amount of color shown on the map, and, since the same veins and faults are mapped nearby in adjoining mines by different men, uniform methods are a necessity. Up to three or four months are spent by "starters" learning the mapping technique, after which close supervision is required to keep the work standard. As far as is possible to do so, all men starting with Anaconda are trained at Butte before being assigned to geological positions elsewhere in the company's worldwide organization.

To direct the development properly the geologist must map all headings at least once each month, but places requiring special attention are sketched after every round. Because it is necessary to plot the geology in workings before accurate transit surveys are made by the mining engineers, compass surveys on 1 in. = 40 ft scale sheets are used and

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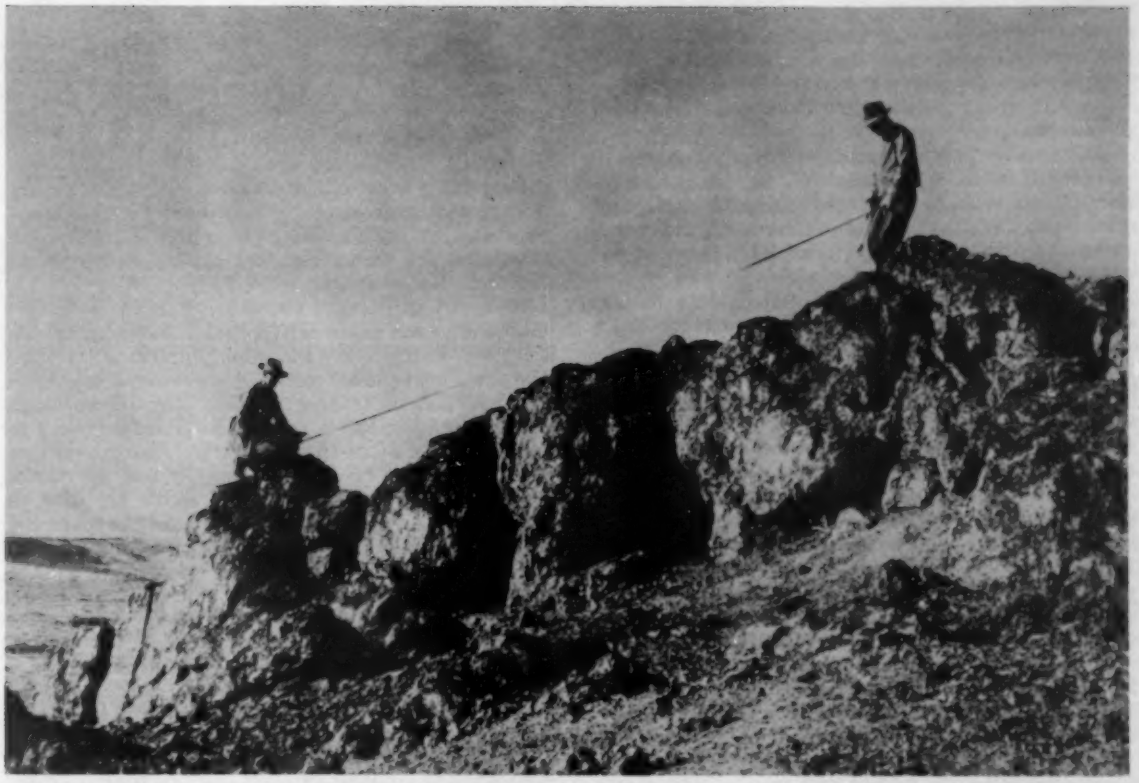


Uniformity of geologic mapping at Butte since 1900 is due to tutoring of new geologists by experienced staff members.

later the notes are transferred to transit-surveyed 1 in. = 50 ft scale maps on linen tracing cloth.

The geologist plots all faults, veins, and stringers, and he records the degree and direction of dip. The relative strength of structure is shown by the amount of color used to depict the structure (blue for faults or red for veins). Side notes are used to describe in detail the mineralization, the wall rock type, and intensity of alteration. These observations are posted on 1 in. = 50 ft scale maps for permanent records. Smaller maps on a scale of 1 in. = 100 ft and 1 in. = 200 ft are used to correlate the structures and recommend additional development work. A set of 1 in. = 100 ft scale maps is maintained in the mine superintendent's office and the advances, when mapped, are posted in pencil. At the end of each month the new transit surveys are added in ink.

An intelligent development recommendation requires a careful study of the plan maps, cross sections and longitudinal sections, and a thorough knowledge of the mineral distribution and geology. Therefore, a complete up-to-date set of geologic cross sections and long sections is kept posted.

RESPONSIBILITIES OF THE GEOLOGIST

The geologist's principal responsibility is to find new ore and to estimate and inventory the reserve developed. He directs the development, maps the geology in all underground headings as they are being advanced, and plots his notes on permanent record plan maps.

Recommendations for development work originate in the Geological Department and are signed by the geologist and Chief Geologist—Butte Operations, and then approved by the General Superintendent of the Operating Department before being sent to the Mine Superintendent. Each recommended project is described in detail, showing the description of the work, including the footage of development drifts or crosscuts required, and the purpose of the project. The recommendations are accumulated by the Mine Superintendent and are driven at a time most suitable to mining operations.

New levels are planned by the geologist before the work is started from the shaft, and the major veins and faults are projected to the horizon of the new level. The geologist and the Mine Superintendent plan the development workings, including drainage, haulage, and ventilation.

Anaconda's ton-for-ton policy at Butte is to develop at least a ton of new ore to replace every ton mined, thus maintaining or increasing the reserves. Each week the geologist estimates the tonnage developed during the week and compares it with the ore shipped to determine if a surplus or deficit was accrued during that period. A formal estimate of ore reserve is made on the first of each year. Beginning with each new year, a cumulative ton-for-ton surplus or deficit is reported to the mine manager weekly, and he directs that development work be retarded or accelerated as may be required to maintain the reserves.

SAMPLING

Definite veins, where the ore minerals are confined within well-defined walls, are sampled from wall to wall, and the country rock broken on either side is measured and sampled for overbreak control. Samples are cut horizontally except in flat dipping veins where they are cut at right angles to the structure. Where veins contain streaks of varying

grades and hardness, the streaks are sampled separately and the average is calculated by combining the individual width and assays of the several parts. This method gives a weighted average by volume only, with no consideration to the specific gravity of the minerals.

Disseminated deposits or deposits containing small veinlets or blebs of ore minerals are sampled similarly to the definite veins. Because of the irregular distribution of the ore minerals, cuts are made vertically and horizontally from top to bottom and across the entire face.

Marginal low grade disseminated deposits are sampled like the others, but larger cuts are taken and specific gravity determinations are made to obtain weighted averages.

Crosscuts are sampled continuously on both sides unless they are known to be barren, drifts are sampled each round, stopes every 10 ft, and raises are sampled on all floors and on both ends.

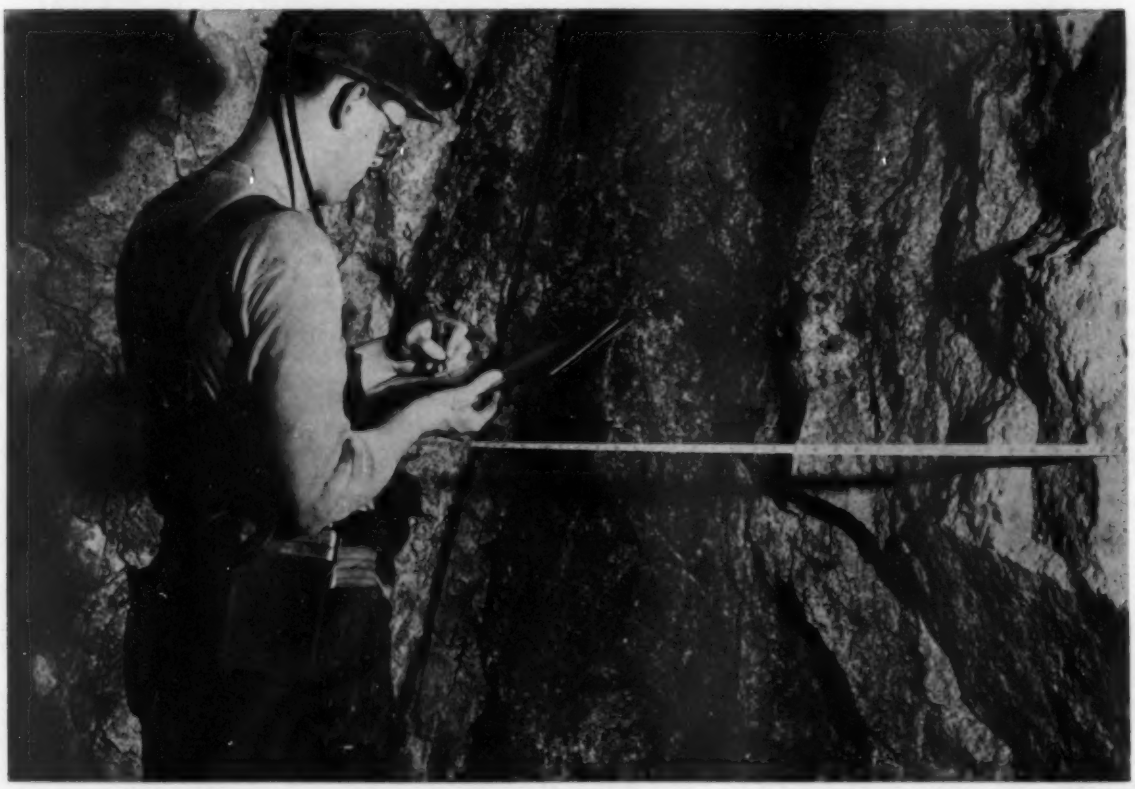
Assay curve cards (see page 268) are used to average sample values in drifts and raises. They show graphically the width and grade of ore along the length of the heading. For drifts the base line is placed horizontally, and the portion of the drift represented by the sample is plotted on a scale of 1 in. = 50 ft. Sample widths are plotted below the line and metal values above. The different metals are shown in separate color. The card gives a visual picture showing the width and grade at any point and averages are easily made for a desired interval between any two points. Raise curve cards are similar to those used for drifts except that two base lines, one for each end of the raise, are shown and the advance is plotted vertically instead of horizontally.

CALCULATING ORE RESERVES

The ore reserve is divided into two groups, *developed* and *probable*. Developed ore is that classification of assured ore reserve which has been proven sufficiently by either drifts and raises, or by drifts alone to permit the immediate extraction of ore therefrom. Blocks are considered developed even if reopening work is necessary to prepare them for mining. Probable ore is that classification of reasonably assured ore located beyond the boundaries of developed ore which requires further development by raises before mining.

Reserves in definite veins are figured on longitudinal sections, but where the mine workings are too complicated to show on section, plan maps are used and the reserve is estimated on each stope floor. The geologist and the mining engineer post the workings on the sections, and a draftsman transfers them to tracing cloth to be printed later. Assay averages are then posted on the tracings. In this operation, the assay curve cards described above are used to average the samples for drifts and raises. After the values are posted on the tracing they become a permanent record, and each year additions are made to show the assay results for the new workings; thus a complete assay record for each vein is assembled on a longitudinal section.

The geologist then successively outlines the ore boundaries on the section diagram; divides the reserve into blocks of similar grade or width; and calculates the average width, grade, and area for each block. These data, together with the block number and vein name, are furnished to an IBM operator who calculates the tonnage and grade of the ore in the blocks.



In those places that require special attention, a mining geologist studies the face after each round of blasting.

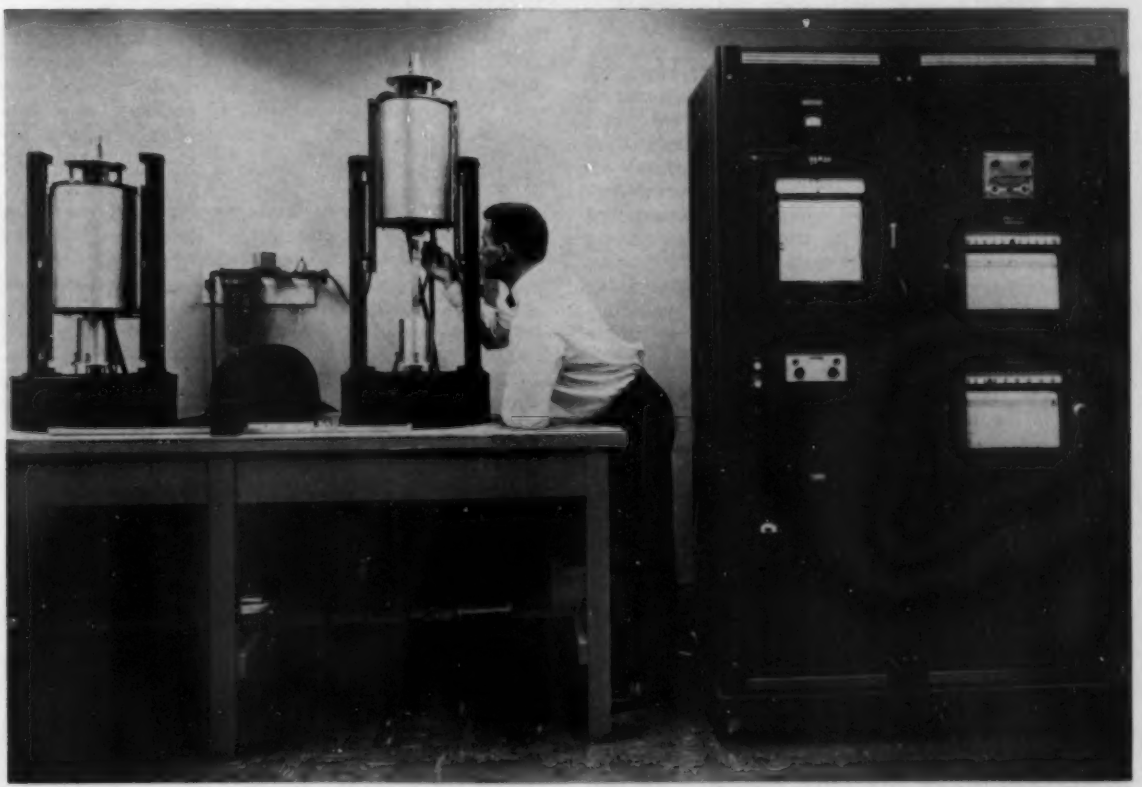
The geologist, working with the Assistant General Superintendent and Mine Superintendent, then classifies the blocks into *Available* (for mining) and *Inaccessible* categories. The Available tonnage is further divided into two classes, "Too Low Grade to Mine under Present Economic Conditions" and "Net Profitable Available" ore, the latter classification being the source of production for the coming year.

GENERAL DEVELOPMENT PLANNING

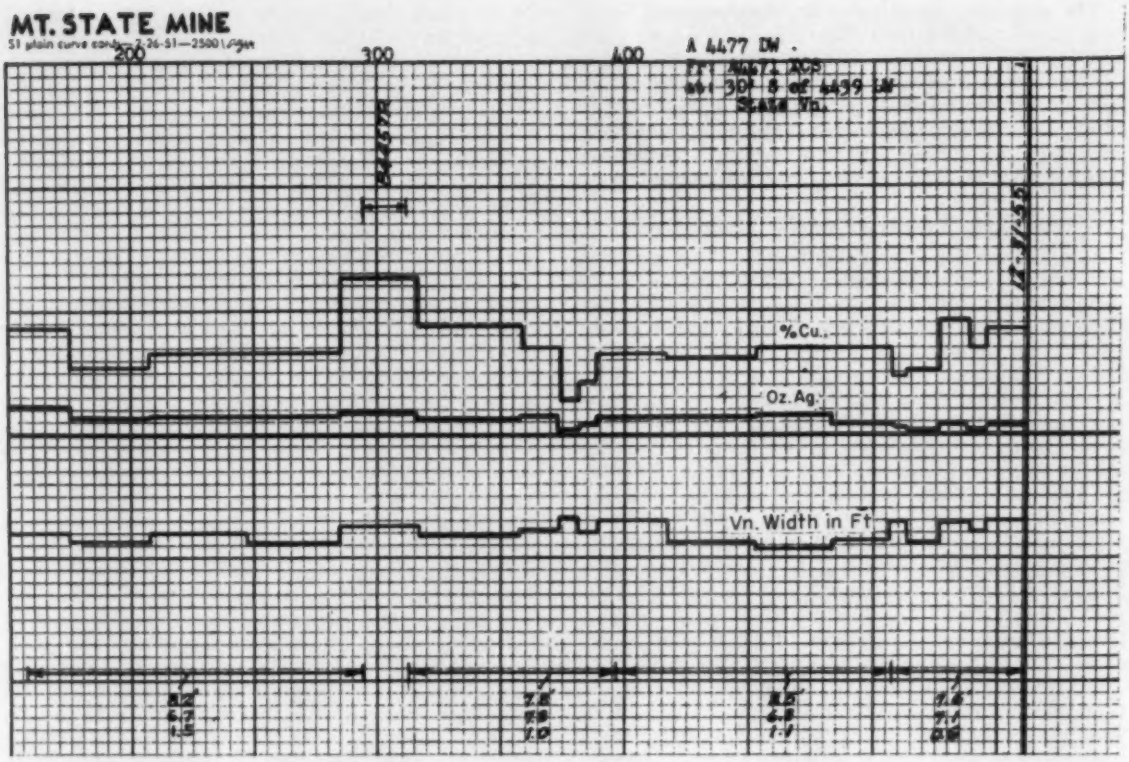
In a district the size of Butte with a vast number of veins, the development of many will be neglected unless they are included in some special program. Many prospects are far from the working shafts and, because ores discovered therein are too distant to be hoisted through the present shafts, special arrangements must be made to distribute the expense of development. In such cases the work is done from one mine but the cost is divided among all the operating units. To plan projects of this kind an over-all district study of the geology is necessary. Plan maps on a scale of 1 in. = 400 ft, and in some cases 1 in. = 1000 ft are used to present the general picture. A series of 1 in. = 100 ft scale geologic cross-sections are prepared along parallel lines 100 ft apart over the entire district. Also, several geologic cross sections on 1 in. = 200 ft scale, sufficiently long to traverse the district, are prepared. The principal veins, showing workings, mineralization, and ore reserves, are plotted on 1 in. = 200 ft scale longitudinal sections, and all this information is used to project ore-shoots and locate new prospects. When the project is advanced sufficiently to demonstrate that enough ore is assured to warrant another shaft, the information gained is used to plan the new unit. Shafts must be located in ground which is free from faults and fault veins, and the Geological Department is called upon to select the best site. The most recent examples of such selections are the Kelley and Missoula shafts.

A thorough analysis of Butte geology based on information gathered over the years is presently being undertaken. This wealth of information had to be transferred into an easily understandable and comparatively compact form to furnish a firm basis for the study. An example of this was the preparation of a set of structure maps on a scale of 1 in. = 400 ft which covers the entire Butte area on one sheet. Several different horizons were shown and a set of plans for each age of vein systems was made to allow a complete study of each system separately without the distracting influence of other veins of different age. This study resulted in a more complete knowledge of Butte structure and answered some of the puzzling questions about the district.

Currently, an exhaustive study of Butte mineralogy is under way. The foundation for this work is the preparation of mineral distribution plan maps and, for the major veins, longitudinal sections on a scale of 1 in. = 200 ft. A separate map is made for each mineral and the various minerals are assigned distinctive colors. The relative abundance of each is indicated by shades of the appropriate color. The economic aspect is shown by the widths of the colored lines representing the veins. Information on the plan maps is being condensed into a graphic representation of minerals on longitudinal sections of the major veins. The knowledge gained from this study will give a better understanding of the distribution of the ore minerals at their time of depo-



A geologic research department with a well-equipped laboratory is maintained at Butte to aid geologic studies.



A typical assay curve card used to average sample values.

sition. The information will be used to predict deep level possibilities and to locate the zones of better copper mineralization. Such data are essential to long range plans.

GEOLOGIC RESEARCH AT BUTTE

A geologic research department is maintained at Butte to investigate rock alteration, and extensive studies designed to relate alteration to mineralization and grade in both vertical and horizontal dimensions are in progress. Criteria relating alteration type and intensity to low-grade disseminated mineralization as well as to high-grade veins are being developed. Information gained through these studies contributes to our fundamental knowledge of the physics, chemistry, and geology of ore deposition, and it will be used as a guide to direct future development projects.

OLD GEOLOGIC RECORDS AID NEW DEVELOPMENTS

Relatively recent projects such as the Kelley and Elm Orlu block-cave mines and the Alice and Berkeley pits, originated in the Geological Department and demonstrated the value of old records. The first estimates of the block-cave ore bodies in the Kelley were made from old geologic notes. The areas on the maps containing sufficient chalcocite stringers, blebs, and disseminations to indicate commercial ore were encircled and the tonnage and grade were calculated using old notes. Later, sampling crosscuts were driven through the zones as outlined, and the results verified the original estimates. Also, information gained in development work since the Kelley was started confirmed the first figures. This is most gratifying when it is realized that the records used were accumulated over a period of 60 years and are the contribution of many geologists.

Similar to the Kelley, the Elm Orlu-Black Rock zinc-lead deposit was initially estimated from old geologic maps. The mineralized areas were measured and grades were assigned as suggested by the side notes in the old records. When sampling crosscuts were driven later, the first estimate proved accurate and the deposit will become a block-caving operation.

Sufficient old notes were preserved at the Alice mine to define the mineralized zone there, and the ore was extracted by open pit methods.

The Berkeley Pit deposit too was first defined using old geologic notes. In the early days the upper levels of the Berkeley, Rarus, Silver Bow, Pennsylvania, St. Lawrence, Moonlight, Mt. View, Anaconda, and Neversweat mines were mapped. Many stringers and disseminations in the quartz monzonite were observed and a low grade copper deposit was recognized. At that time no mining methods were known that would insure a profit. However, when open pit techniques were advanced sufficiently to make the deposit an orebody, the area was considered as a source of copper production. Similar to the other projects, the first appraisal was made using geologic notes and the tonnage and grade were estimated. Later, churn drilling verified the first calculation and the pit was started.

In summary, Anaconda's experience during the last 60 years has proven the value of a well organized Geological Department. The use of geology in Butte resulted in the discovery and development of sufficient ore reserves to permit a successful operation in the past and to assure its continuance for many years to come.

ECONOMIC JUSTIFICATION FOR FROTH FLOTATION OF COAL

One of the major problems confronting coal producers in this highly competitive era is whether or not the potential profit to be made from the products of coal flotation would warrant the capital investment required for the necessary equipment. The author supplies two theoretical cases to illustrate methods for computing such costs.

by JAMES W. MILLER

Because of the depressed markets today, vicious competition has developed in the coal industry. This competition has demanded that each coal company examine every possibility of improving its mining operations. Under this stimulus coal preparation engineers have found it necessary to project the maximum recovery at the lowest operating cost.

Methods for improving the efficiency of preparation plants are of utmost importance to us all, but it must be remembered that improved efficiency and reduction in mine costs do not always justify a capital expenditure. Proper justification for a capital expenditure is based primarily on the length of time necessary to recover the dollars invested in the improvements. The recovery time needed for each investment can only be determined by the individual company policy.

Due to the many risk factors present in the coal mining industry today, few dollars are being invested unless the pay-off time is very attractive. Some of these are the risks of coal demand, competition, and fluctuating market prices and coal quality. Because of these risks and their effect on investments, it is thought that a capital expenditure in a froth flotation installation is justified in some cases but not in others.

It may appear that the only additional cost involved in recovering fine sizes of coal lost to a river, stream, or settling pond is that involved in the preparation plant. If this were the case, the direct mine cost would be reduced markedly and justification for the capital expenditure would be extremely attractive.

It has been found, however, that there are many other factors which must be considered in justifying this expenditure. Some of these are quality of coal, freight rate, royalty, welfare fund, association dues, and taxes on the additional tons recovered. In addition to these, Federal income taxes on profits have a serious effect on the return time of an investment. These factors are of paramount importance in evaluating an expenditure in froth flotation.

In one day's time or in one year's time, practically all of the direct costs at a mine are fixed relative to dollar expense. There are other indirect costs directly affected by the number of tons shipped. These are royalty, welfare fund, association dues, and taxes. Generally these costs amount to $0.70 per ton of material shipped. This material can be water, coal, or refuse.

A vitally important item which must be taken into consideration is the freight rate from the mine to market. In the demonstration which follows, a freight rate of $4.56 per net ton is used, this being the rate from the mine to a major utilization point.

METHODS OF DETERMINING CAPITAL EXPENDITURES IN RELATION TO ACTUAL COST BENEFITS

The case which follows is one that might be found in many places in the coal industry. Assume that there is a mine producing 4000 tpd of raw coal. This mine has a 25 pct reject and ships 3000 tons of clean coal. At the present time, 133 tons of coal are being pumped to a settling pond because it is too high in ash to ship to market. This market uses metallurgical coal and pays $9.66 per ton delivered to the ovens. The specifications on which the $9.66 per ton is established are 5.0 pct moisture, 4.75 pct ash, and 1.00 pct or less sulfur.

After a study, it has been estimated that froth flotation can be installed for $120,000. With this equipment, 75 pct of the coal being pumped to the settling pond can be recovered at 5 pct ash. The question arises, then: How long will it take to recover the $120,000 invested in this equipment and, hence, is froth flotation justified?

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Table I shows the analysis of the present product being shipped, the anticipated analysis of the fine coal to be recovered from the settling pond, and the analysis of the combined product to be shipped.

Several things in this table are called to your attention. The as-received ash on the product being shipped is 4.75 pct and the dry ash 5 pct. The dry ash is also 5 pct in the flotation product and the combined product. It is assumed that the moisture content of the filter cake will be 30 pct and, therefore, the moisture will increase to 6.14 pct in the combined product. It is recognized that this moisture could cause a sales problem; however, we may assume that this product would still be acceptable at market.

It is questionable whether heat drying is justifiable on the ultrafine sizes of coal and, therefore, the filter cake material will be shipped without heat drying.

Table II shows the tonnage presently being shipped, the tons to be recovered by flotation, and the combined tonnage that would be shipped with the flotation fines included. It also shows that the present recovery can be increased 3.6 pct by recovering 100 tons of coal presently being pumped to the settling pond. Note the high recovery of the flotation coal on an as-received basis because of the 30 pct moisture content; also note that only 33 tons of slurry will be pumped to the settling pond as compared to 133 tons at the present time.

Table III shows a summary of the total delivered-cost to the ovens. The increased costs at the plant are estimated at $0.41 per ton of flotation coal recovered, these being maintenance, supplies, power, and depreciation on a $120,000 capital expenditure. However, the total mine cost would be reduced from $4.90 to $4.73 per ton if the flotation coal is recovered. This reveals a $0.17 per ton reduction in total mine cost. Since the freight is the same in both cases, this also means a $0.17 per ton reduction in the total delivered cost.

It has been stated that the realization is $9.66 per ton of coal delivered. This same realization on a dry basis is then $10.17 per ton since 5 pct of the product shipped is water.

Assume that it is possible to maintain the realization of this coal on a dry basis. The value of the combined product on an as-received basis is then $9.55 since 6.14 pct of the product shipped is water.

Table IV clearly shows a return on the investment after taxes of $26,849 per year. This is approximately a 4½-year pay-off time.

The previous demonstration has assumed that the ash and sulfur in the flotation product could be reduced to a quality comparable to the product presently being shipped. This is of utmost importance because of the extremely high penalties placed on ash and sulfur at the blast furnace. The steel industry has made great strides in increasing blast furnace production. This has been accomplished by beneficiating the raw materials charged and also injecting fuel into the smelting zone. Since the ash and sulfur in coke decrease blast furnace capacity, it is very questionable whether any increase in these constituents would be tolerated.

Following are some of the observations of blast furnace men pertaining to ash and sulfur in the coke:

Ash

1) As the ash content of the coke increases, the heat value decreases, demanding more coke.
2) As ash increases in the coke, more limestone is needed for its removal, decreasing the capacity of the furnace.
3) As coke ash increases, the physical qualities of coke usually decrease, resulting in increased losses of coke breeze.
4) Some blast furnace operators think that, if the coke ash increases 1 pct, iron production will decrease from 2 to 3 pct.

Sulfur

1) As sulfur increases, slag volumes usually increase, reducing capacity.

Table I

	Present Production		Flotation Production		Combined Production	
	As Rec'd.	Dry	As Rec'd.	Dry	As Rec'd.	Dry
Moisture, pct	5.00	—	30.00	—	6.14	—
Ash, pct	4.75	5.00	3.50	5.00	4.69	5.00
Volatile, pct	32.30	34.00	23.80	34.00	31.91	34.00
Fixed Carbon, pct	57.95	61.00	42.70	61.00	57.26	61.00
	100.00	100.00	100.00	100.00	100.00	100.00
Sulfur, pct	1.00	1.00	1.00	1.00	1.00	1.00

Table II

	Present Daily Production		Flotation Coal		Combined Daily Production	
	As Rec'd.	Dry	As Rec'd.	Dry	As Rec'd.	Dry
Raw coal—tons	4,000	3,800	140	133	4,000	3,800
Pct Recovery	75.0	75.0	102.1	75.0	78.6	77.6
Clean coal—tons	3,000	2,850	143	100	3,143	2,950
Refuse—tons	—	950	—	33	—	850

Table III

	Present Daily Production		Flotation Coal		Combined Daily Production	
	As Rec'd.	Dry	As Rec'd.	Dry	As Rec'd.	Dry
Tonnage shipped	3,000	2,850	143	100	3,143	2,950
Moisture	5.00%	—	30.00%	—	6.14%	—
Total direct mine cost per ton	$4.20	—	$0.41*	—	$4.03	—
Royalty, welfare, association dues, and taxes	0.70	—	0.70	—	0.70	—
Total mine cost per ton	$4.90	—	$1.11	—	$4.73	—
Freight per ton	4.56	—	4.56	—	4.56	—
Total delivered cost per ton	$9.46	—	$5.67	—	$9.29	—
Realization per ton	$9.66	$10.17	—	—	$9.55	$10.17

* Depreciation $120,000 (20 years) $0.21
Maintenance, supplies, and power 0.20
$0.41

Table IV

	Present	Combined
Tons shipped daily	3,000	3,143
Realization per ton	$9.66	$9.55
Total delivered cost per ton	$9.46	$9.29
Profit per ton	$0.20	$0.26
Profit per day	$600.00	$817.18
Annual profit (200 days)	$120,000.00	$163,436.00
Increased annual profit before taxes	—	$43,436.00
Increased annual profit after taxes	—	$20,849.00
Annual depreciation	—	$6,000.00
Annual return on investment	—	$26,849.00
Required pay-off time (years)	—	4.5

2) As sulfur increases, more coke is consumed.
3) Furnace control is more difficult when the sulfur is increased, and irregular operation usually results.

A blast furnace superintendent is interested in both the physical and chemical characteristics of the coke used. However, his major interest must be in the cost per ton of effective carbon in the coke delivered. *Effective carbon* is defined as the amount of carbon available for ore reduction after allowances have been made for the removal of the harmful constituents in the coke. The steel industry has established that, when utilizing coke in the blast furnace, one unit of carbon is necessary to remove one unit of ash and three units of carbon are necessary to remove one unit of sulfur.

To illustrate the effect of an increase in ash on the value of the coal at the blast furnace, assume that there is a second case in which the flotation coal would analyze 2 pct higher in ash than that shown in the previous illustration.

Table V shows the dry analyses of the coal, flotation product, and the two combined, with a 2 pct increase in ash in the flotation coal. This table also shows a calculated coke analysis, assuming that on a theoretical basis no moisture or volatile matter remains in the coke. The coke yields are based on the recovery at 100 pct of the fixed carbon and ash, including sulfur in the coal.

The realization per ton of dry coal is $10.17 as shown in Table III. Since 54.89 pct of this coal is effective carbon, the delivered cost per ton of effective carbon is $18.53. Based on the cost per ton of effective carbon, it is found that the value of the combined product with 6.14 pct moisture has decreased from $9.66 in the present product to $9.53 per ton, or a loss of $0.13 per ton.

Table VI shows the return on the $120,000 capital expenditure if the flotation product is increased 2 pct in ash. This return on the investment after taxes is $20,815 per year, or approximately a 6-year pay-off time.

In the two cases described in the foregoing tables, a method to determine the time needed to pay off an investment of $120,000 in froth flotation equipment has been shown.

This method has taken into consideration the following: increased preparation costs; depreciation on the new equipment; increased cost of royalty, welfare, association dues, freights, and taxes on the filter cake to be shipped; freight rate; income taxes on increased profits; and the adjustments in realization because of increased moisture and ash in the filter cake shipped.

In many cases in the industry, justification for capital expenditures is based entirely on the reduction in direct mine costs. Many of the factors mentioned in the previous demonstrations are not taken into consideration.

In the arbitrary case presented in Tables I, II, III, and IV, the total mine cost has been reduced $0.17 per ton. On 3143 tons per day, an annual benefit in a 200-day year would be $106,862. This would mean a pay-off time on a $120,000 expenditure of about 13 months. Taking all factors into consideration, Table IV shows a 4½ year pay-off time is necessary and, if the product is 2 pct higher in ash, Table VI shows an approximate 6 year pay-off time.

The following tabulation* indicates what mining companies think about the required pay-off periods for new equipment in the coal industry.

2 Years or Less	20%
3 Years or Less	35%
5 Years or Less	65%
10 Years or Less	95%

This survey indicates that 65 pct of the companies operating in the industry require a 5 year or less pay-off time. Since the $120,000 expenditure in the froth flotation installation previously illustrated had a pay-off time of 4½ years, it has a 65 pct chance of being installed, since 35 pct of the companies do not think this return time justifies the expenditure. If the ash would increase 2.0 pct in the concentrate, this installation would have a 35 pct chance of being installed because of the 6 year pay-off time, and 65 pct of the companies would think froth flotation would not be justified.

It is thought that, in virtually every case, froth flotation has economic advantages to offer the coal operator. Each coal company, because of its individual position, requires different pay-off times on investments. Hence, it is incumbent upon each operator to decide whether a 2, 4, 6, or 10-year pay-off time is necessary to justify the capital invested.

* Based on a survey by McGraw-Hill, Department of Economics.

Table V

	Present Product		Flotation Product		Combined Product	
	As Rec'd.	Dry	As Rec'd.	Dry	As Rec'd.	Dry
Coal Analysis						
Moisture, pct	5.00	—	30.00	—	6.14	—
Ash, pct	—	5.00	—	7.00	—	5.07
Volatile matter, pct	—	34.00	—	33.28	—	33.98
Fixed Carbon, pct	—	61.00	—	59.72	—	60.95
		100.00		100.00		100.00
Sulfur, pct		1.00		1.00		1.00
Coke Analysis						
Fixed Carbon, pct	—	92.42	—	89.51	—	92.32
Ash, pct	—	6.74	—	9.65	—	6.84
Sulfur, pct	—	0.84	—	0.84	—	0.84
		100.00		100.00		100.00
Yield		66.00		66.72		66.02
Carbon needed to remove sulfur, pct	—	2.52	—	2.52	—	2.52
Carbon needed to remove ash, pct	—	6.74	—	9.65	—	6.84
Carbon needed to remove ash and sulfur, pct	—	9.26	—	12.17	—	9.36
Effective carbon per ton of coke, pct	—	83.16	—	77.34	—	82.96
Effective carbon per ton of coal, pct	—	54.89	—	51.60	—	54.77
Realization per ton coal delivered	$9.66	$10.17	—	—	$9.53	$10.15
Delivered cost per ton of effective carbon	—	$18.53	—	$18.53	—	$18.53

* Calculated by formula developed by Lowry, H. H., AIME, Trans., vol. 140, 297-330 (1942).

Table VI

	Present	Combined
Tons shipped daily	3,000	3,143
Realization per ton	$9.66	$9.53
Total delivered cost per ton	$9.46	$9.29
Profit per ton	$0.20	$0.24
Profit per day	$600.00	$754.32
Annual profit (200 days)	$120,000.00	$150,864.00
Increased annual profit before taxes	—	$30,864.00
Increased annual profit after taxes	—	$14,815.00
Annual depreciation	—	$6,000.00
Annual return on investment	—	$20,815.00
Required pay-off time (years)	—	5.8

GOUVERNEUR TALC CO.'S DRY BLENDING METHOD FOR FINELY GROUND MATERIALS

by ROBERT S. McCLELLAN

In order to meet the ever-increasing demand by consumers for uniformity of ground talc, a new method of blending its finished product has been developed by Gouverneur Talc Company, Inc., at its plant near Gouverneur, N. Y. The method has been in use for a sufficient length of time to be now judged a success.

The Gouverneur district is the leading talc producing area of the world, inasmuch as more tonnage is produced there than from any other state in the U.S. or, so far as is known, from any other locality in the world. Almost all of the output goes into industrial uses, with ceramics and paint being the principal consuming industries. The physical and chemical specifications imposed by these industries are stringent and the trend, as in most industries, is toward ever increasing severity. The blending method described herein has aided Gouverneur Talc to keep up with this trend.

The ores of the Gouverneur district are generally of the tremolitic talc variety and are mined by underground methods. Gouverneur Talc's mine has been developed to a depth of 700 ft with three main haulage levels at 300, 500, and 700 ft. Five different grades of ore are mined by open stope methods.

Since the consuming industries require the talc in its dry state, the ore coming from the mine is dry-ground by either of two methods:

In a pebble mill circuit, which includes three 120 x 66-in. mills with mechanical air separators. The grades produced by this circuit are used principally by the ceramic industry and to some extent by the paint industry.

In a fluid energy circuit, which includes fourteen mills. The principal grade produced by this circuit has an average particle size of about five microns and is used almost exclusively by the paint industry.

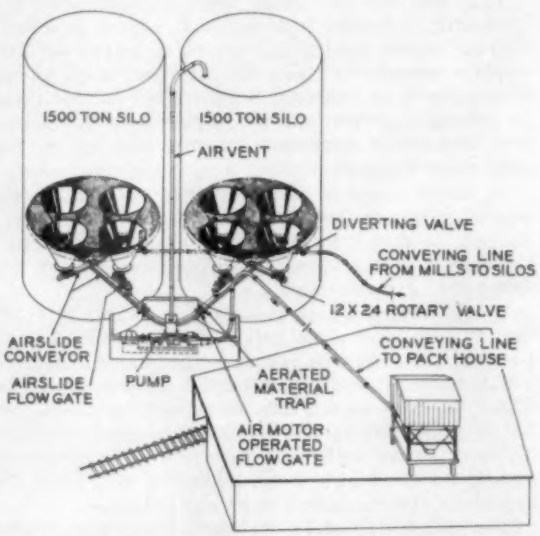
Following grinding, the finished grades are pumped in the dry state to thirteen finished product bulk storage silos, with capacities ranging between 90 tons and 1500 tons each. The material is reclaimed from these silos as needed and pumped to bulk hopper cars or to the bagging plant where it is packed in 50-lb, multiwall paper bags for rail shipment.

DESIGN OF NEW BLENDING FACILITIES

The old method of filling the finished product silos and reclaiming from them did not bring about much blending of the stored material. It also permitted a certain amount of segregation to take place in the silos, with the result that there was not as much uniformity in quality from carload to carload as the company desired, even though all carloads were within customer specifications.

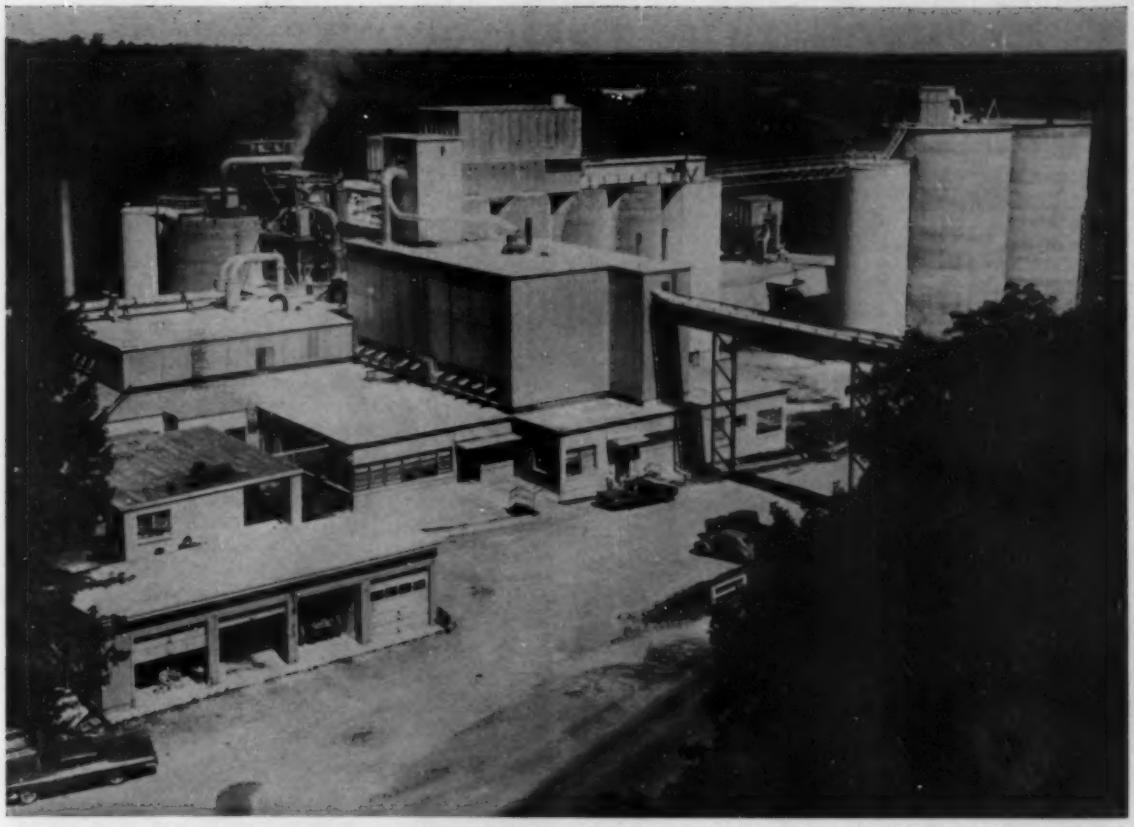
The former method of filling the silos consisted simply of pumping the material through 4-in. and 5-in. pipelines to the top of the silos where it was discharged into them from the center of the roof. It was learned by experience that some segregation of material took place because of the tendency of the extreme fines to travel further down the cone under the discharge point than the coarser material. It was also found that as the material was reclaimed through the single conical bottom of these silos, very little mixing of the material in the silo occurred.

The first step taken to overcome these difficulties consisted of an experiment to determine whether ground material could be pumped into the bottom of a silo, instead of into the top in the conventional way. Because of the fluidity of the material resulting from the air entrained during the pumping operation, it was believed that this might work. Experiments proved that it would, and it was found that a considerable amount of mixing took place during the filling operation and segregation of material was eliminated. The mixing takes place because of the fact that as the fluidized talc enters the bottom of the silo, a zone of material, ten feet or more in diameter and extending the full depth of the bed of the material in the silo, becomes fluidized and the incoming material thus mixes continuously with the material already in the silo.



Diagrammatic drawing of the new talc blending facilities.

R. S. McCLELLAN, Member AIME, is Vice President of Gouverneur Talc Co. Inc., Gouverneur, N. Y.



View of the plant and storage silos of the Gouverneur Talc Co., as seen from the top of the mine headframe.

This fluidized channel, which extends from the bottom inlet to the top of the material, does not remain fixed. Following the path of least resistance, it moves from place to place so that the new material mixes with a substantial proportion of the contents of the silo. A definite increase in uniformity of shipments resulted from this step. Another beneficial effect is that when material is entering the silo through the bottom, withdrawal from the silo is more uniform and easier to control because of the fluidizing effect of the inlet stream. Inasmuch as this experiment was successful, steps were taken to change over the filling arrangements of other existing silos. This has been done with results that are equally as good.

At about this time, the need for additional storage of the finished product became apparent, and it was decided to build two new silos, each measuring 40 ft in diameter and 77 ft high. In the design of these silos, a further step was taken to assure uniformity of the talc product by providing multiple withdrawal points in the bottom of the silos so that the material could be withdrawn from all points simultaneously and blended together. It was believed that this design, plus the bottom-filling feature, would result in a degree of uniformity hitherto unobtainable.

The silos were built of reinforced concrete with walls 15 in. thick and with flat floors 20 ft above ground level. (As a matter of interest, the silo walls were completed in five working days, using a Swedish slip-form process.) Four 60° conical steel hoppers were provided in the floor of each silo; the cones are 12 ft high with 15-ft diam. Each cone discharges by gravity into a fluidizing conveyor. The fluidizing conveyors converge so that by the time the material reaches the pump which delivers it to the packhouse, thorough blending has taken place. The system has a capacity of 50 tph.

Since the same grade of material is stored in both silos, the material can be reclaimed from eight points at once, and good mixing is inevitable. Glass windows in the sides of the fluidizing conveyors permit regulation of gates controlling the flow of material from each cone so that approximately equal amounts are drawn from each one.

Material from the mills is pumped into the silos through pipelines terminating near the tops of two of the cones in each silo, with provision made so that it can be pumped later into all four cones if necessary. Present practice is to pump into one cone for eight hours and then switch to the other cone located directly opposite the first.

The reclaiming conveyors are controlled by bin level indicators in the bin above the bag-filling equipment. This bin level indicator controls the starting and stopping of blowers supplying air to the fluidizing conveyors and also controls the pump which delivers material to the packhouse bin.

The operation of the entire system has come fully up to expectations in the 15 months since the silos were completed, with quality variations from carload to carload being in a much narrower range than ever before realized. While the advantages from the standpoint of customer acceptance are obvious, there is another big advantage in that this system permits much more flexibility in planning mine production at Gouverneur than was formerly the case.

HYDRAULIC TRANSPORTATION OF FLORIDA PHOSPHATE MATRIX

INTRODUCTION

by

HARVEY B. HARDY and SVEND A. CANARIIS

The long haul begins when a dragline dumps the phosphate matrix into a prepared well. High pressure hydraulic guns then drift the slurry through a grizzly where a suction lift pump picks up the slurry and pipes it to the recovery plant for processing.

The phosphate pebble-bearing matrix in the Florida Phosphate Pebble Field has physical properties which make it readily adaptable to hydraulic transportation methods employing solids-handling pumps and pipelines. The abundance of water available, a practically flat terrain, low costs per ton-mile, and beneficiation of the matrix by agitation while being pumped have contributed to the popular choice of hydraulic transportation.

Phosphate pebble mining in Florida, begun in the 1860's, first used high pressure water and solids-handling pumps for overburden removal about 1900. Removal of the average 25 ft of overburden was followed by hydraulic mining of the matrix, with 6-in. and 8-in. pumps handling 50 to 100 cu yds per hour being moved along the floor of the pit as they were advanced toward the face being undercut and slurried by hydraulic guns.

In the 1920's draglines were introduced to strip overburden and, about 1935, began to be employed also to dig the matrix; with this operation the matrix was dumped in a sump at ground level, where it was slurried and pumped to the recovery plant.

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Demand for more production and availablity of heavier equipment to move larger pumps had caused a gradual increase to 12-in. pumps and 14-in. pipe through the early 1940's and, by 1950, to 14-in. or 16-in. pumps and 16-in. pipe. The largest pipe being used today in matrix pumping service is 20-in. I.D. Pipeline length has increased to more than five miles in some cases, since it has proven more economical to transport the matrix over such distances than to construct new recovery plants closer to the mine location.

The composition of the matrix varies widely in percentages of pebble, flotation feed, slimes (everything finer than 150 mesh), and silica tailings and in the character of these components. Thus the mining cost and pumping costs vary widely. In general, to produce one ton of shipping grade rock it is necessary to remove 6 to 8 tons of overburden, pump three tons of matrix to the recovery plant, and to dispose of two tons of sand tailings and clay slimes as waste.

The character of the matrix affects the density of the slurry that can be supplied to the pump at the sump or "pit" and also the friction loss that must be overcome in the pipeline. It is found that the percent solids by weight of matrix in the usual

slurry may range from 25 to 45 pct. Using a specific gravity of 2.7 for dry rock and 1.282 for the slurry (35 pct solids by weight), 8000 gpm of slurry would carry about 700 cu yd per hour of matrix as mixed. This amounts to 778 ltph of dry matrix for a typical condition where matrix as mined contains 20 pct moisture by weight and weighs 120 lb per cu ft as mined.

Allowing a TDH per pump of 150 ft and using a friction loss of 30 ft per 1000 ft of 16-in. I.D. pipe (Williams and Hazen C=130), the pit pump and relay stations operating from sumps could handle 4300 ft of pipe, while series connected booster or "lift" pumps could handle 5000 ft. With a pump efficiency of 70 pct, 555 bhp would be required per unit. Thus a system utilizing a pit pump and two booster pumps would require 1665 bhp to pump through 14,300 ft of pipe, (assuming no static head), and for continuous pumping at an average slurry density of 1.282, there would be a requirement of .67 Kw-hr per ton-mile, (using a motor efficiency overall of 85 pct). This example illustrates one of many possible situations involving different slurry densities, pipe friction losses, static head changes, and production requirements.

The following three sections of this article will point out differences in mining and pumping operations by three different companies engaged in phosphate mining. Obviously the different methods of control will result in different operating costs and maintenance costs, making an average cost figure difficult to find. In general, the cost of maintenance of the pumping units averages $1.50 per hour and the cost of replacing pipe after 6,000,000 tons of matrix have been pumped averages $.0077 per ton-mile. Operators for the pumping and gunning operations will average $.0068 per ton-mile. Supplying the gun water at the pit to be used in making up the slurry at 150-200 psi is another direct cost of hydraulic transportation of the matrix. This requires approximately 1 bhp per long ton of matrix.

The table below summarizes some direct costs per ton-mile based on the situation described above, where three pumps are used in a pipeline 2.81 miles long:

1) Pumping cost, at 1.1¢ per kw-hr	$0.0074
2) Pumping cost, hydraulic gun water	.0034
3) Cost of hourly employees, operators	.0068
4) Cost of pipe line replacement	.0077
5) Cost of pumping unit maintenance at $1.50 per hour per unit	.0023
6) Interest on investment	.0020

No costs of electrical transmission or of obtaining "rights-of-way" for pipelines or electrical line are included, nor are overhead costs such as insurance and supervision.

With improvements in pipeline operation and lowering of maintenance and labor costs expected with increased use of automation, the future will probably find pipelines becoming longer and capacities greater.

HYDRAULIC TRANSPORTATION AT ACHAN AND NORALYN MINES

by

MATTHEW T. SMITH

During the decade beginning 1940, International Minerals & Chemical Corp. used 12-in. pumps and 14-in. I.D. pipelines in their mining operations. Beginning about 1950, the production demands increased sharply, and the size of pumping equipment also increased until the 16x48 ½-in. pump now in use was developed. These pumps are capable of handling in excess of 15,000 gpm of slurry, thereby transporting 2000 cu yd of matrix per hour.

During recent years, considerable attention has been directed toward increasing the life of wearing parts of solids-handling pumps. This has included investigations of various alloys to increase hardness for better withstanding wear, and also the testing of various rubber compounds and plastic materials for possible application as liners inside metal pipe or pump casings to resist abrasion.

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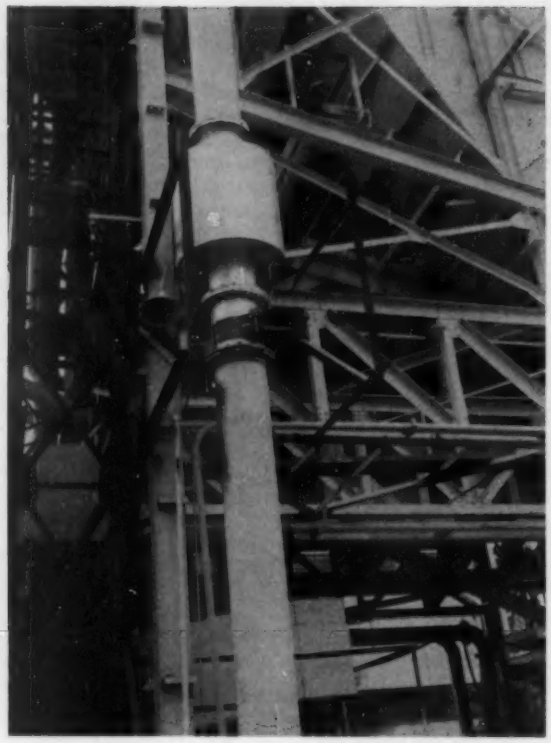


Enlarged section of pipe (left photo) is the electromagnetic flowmeter which measures gpm flow of slurry in pipeline and transmits this information to a recording meter. A density cell, fastened to a spool directly beneath the flowmeter, measures density of the slurry, and this information is also transmitted to a recording meter. Cabinet (right photo) houses electronic computing and integrating devices which combine the data from the flowmeter and the density cell and compute the "dry long tons per hour" being transported.

The efficiency of pumping systems and their component parts also receive very close attention. One of the devices used to provide continuous data on pumping performance is shown in the accompanying photograph. This device utilizes a flow-meter to determine gallons per minute being pumped, a density meter to determine the percent solids, and integrator to convert this information into dry tons per hour being transported by the system.

International Minerals & Chemicals Corp. currently operates two mines in the Florida pebble phosphate field: the Achan mine located four miles south of Mulberry, Fla., and the Noralyn mine located four miles south of Bartow, Fla.

The deposits mined at the two locations differ considerably. At Achan, the major portion of the phosphate rock produced is plus 16 mesh material, with a smaller tonnage of minus 16 to plus 42 mesh material being recovered in a Humphrey Spiral plant. Noralyn production is mainly a flotation and spiral concentrate ranging in size from minus 16 to plus 150 mesh. The amount of plus 16 mesh rock produced varies over a wide range, at times accounting for as much as 35 pct of total production and at other times being almost nil. The Achan matrix contains approximately 30 pct slimes, mainly present as a stiff clay. The Noralyn matrix has an average slime content of 23 pct. The clays in the Noralyn matrix are usually quite soft throughout the depth of the deposit, although, locally, bands of stiff clay are present. The amount of slimes present and their stiffness are important since they can seriously affect mining rates, beneficiation process, and waste disposal requirements.

In order to expose the phosphate-bearing matrix for mining, a 15 to 25 ft depth of overburden is stripped by large draglines, utilizing buckets up to 30 cu yd in capacity, and with digging and dumping ranges exceeding 200 ft. Several stripping practices are in effect. Where mining ratios are most favorable, a single machine may strip overburden and mine matrix, alternating between the two for short periods of time. Where mining ratios are less favorable, a portion of the cut width is stripped to matrix with the remaining width being stripped simultaneously during matrix mining; or a portion of the overburden depth is removed for the full width of the cut. This latter method requires placing the dragline on a bench below ground level in order to remove the remaining overburden and mine the matrix. In all instances, the overburden is cast into adjoining mined-out pits. The width of cut mined varies from 200 to 350 ft, with 250 ft being the most commonly used dimension.

The matrix is always mined with draglines, being dug from the exposed bank after stripping, and dumped into a prepared sump or well. The well or sump into which the draglines dump, and from which the pit pump picks up the slurry, together with its related equipment, is laid out with considerable care. The well itself consists of two parts: the portion from which the pump suction draws the

slurry, including the location of trap or grizzly, and the larger area or apron where the dragline empties its load.

The deep part of the well from which the pump suction draws the slurry is 8 ft deep, 14 ft wide, and about 20 ft long. A portable, 8x14 ft, steel grizzly is set in front of the pump suction pipe, with the forward edge even and in line with the rear edge of the flared portion of the well. Metal wingwalls about 8 ft high and 12 ft long are joined to the front corners of the grizzly and extend along the bank which makes up the back portion of the flared part of the well. These wingwalls prevent the washing away of the bank at the ends of the grizzly. The grizzly bars are usually placed on 8-in. centers but this spacing is varied, depending on the type of material being mined. Low sides several feet high extending across the ends and back of the grizzly prevent oversize material from getting into the suction well. The grizzly itself is located about five feet above the well bottom on a rack, so built as not to obstruct the flow of material through the grizzly.

All matrix is drifted onto this grizzly and must pass through it to get to the pump suction. A water gun is placed in a position where its stream can beat directly on the grizzly to assist in breaking up mud balls. Rocks or roots can be swept off with a gun or removed by hand. The standard pit setup utilizes three guns. The usual practice is to mount all three guns on a sled approximately 20 ft long. The sled carries a hydraulic water manifold from which the guns and gun controls are fed. The manifold is bolted directly to the end of the hydraulic pipeline and eliminates the need for three-way distributors, ball joints, and individual gun lines. Hydraulic controls are used with individual valves for horizontal or vertical motion. Gun tip sizes are changed to meet matrix conditions and the amount of water needed, as well as to vary the pressure as required. Hydraulic water is normally water which has been used at the plant, clarified in settling ponds, and recirculated for further use. The amount used ranges from 5000 to 8000 gpm, depending on the type and volume of matrix being handled. Pressures at the gun tips can be varied from 100 to 350 psi. Hydraulic pipelines have 24-in. ID with ¼-in. mild steel sidewall and 250-lb flanged connections. This size pipe gives a pressure loss of less than 2 psi per 1000 ft of pipe when supplying 8000 gpm of hydraulic water.

The hydraulic water pumping system consists of a 16x14-in. single stage pump, rated at 8000 gpm at 200 ft of head, which picks up the water from a reservoir and discharges it into the mine hydraulic line. Sufficient booster pumps in the line give the required pressure and volume at the mine.

HYDRAULIC PUMP SYSTEM

Crews: A mine crew consists of one Hydraulic Operator who is in charge of pit operations, and three helpers who operate the guns, tend the pit pump, keep the grizzly clear of debris such as large rocks, roots, etc., and perform other necessary duties. A fourth man services the lift pumps and hydraulic water pumps in regard to packing adjustment, lubrication, and minor maintenance such as tightening bolts, etc.

Pumps: The first hydraulic pump is operated by remote control from the pit. A small vertical priming pump which discharges into the pump suction automatically starts when the hydraulic pump shuts down, thus assuring a full prime on the pump at all times. The booster pumps are operated with pressure switches placed upstream in the hydraulic line. They are set to start the pumps at 50-lb pressure and stop them at 20-lb pressure. A recording meter in the hydraulic line gives a daily record of the amount of water used. This figure is used mainly as a check on the percentage of solids being pumped from the pit.

The pit pumps now in use are 16x48½-in. dredge pumps, equipped with 42-in. impellers. They are driven by 600-hp wound rotor motors with variable speed control effected through the use of grids and contactors, and controlled remotely by a member of the crew in the gun control house. Pump suction pipes are 24-in. I.D. with a 48x24-in. bell on the submerged end which is used to reduce entrance head losses. The suction is raised or lowered by an electric winch mounted on the pit car. Priming water is introduced through a 4-in. pipe which discharges into the impeller eye. The pump is run at low speed with the priming water turned on, and in a few minutes a prime is effected. This arrangement eliminates the need for a flap valve and is a very satisfactory method of pump priming.

The lift pumps used are also 16x48½-in. dredge pumps, normally operated with 42-in. impellers. The first lift pump is located within 1500 ft of the pump, and the other lift pumps are set about 2500 ft apart. These distances are subject to change, based on the terrain crossed by the pipelines if there are sufficient differences in elevation to affect the static head on the pumping system. Basically, pump spacing is calculated after three main factors are investigated:

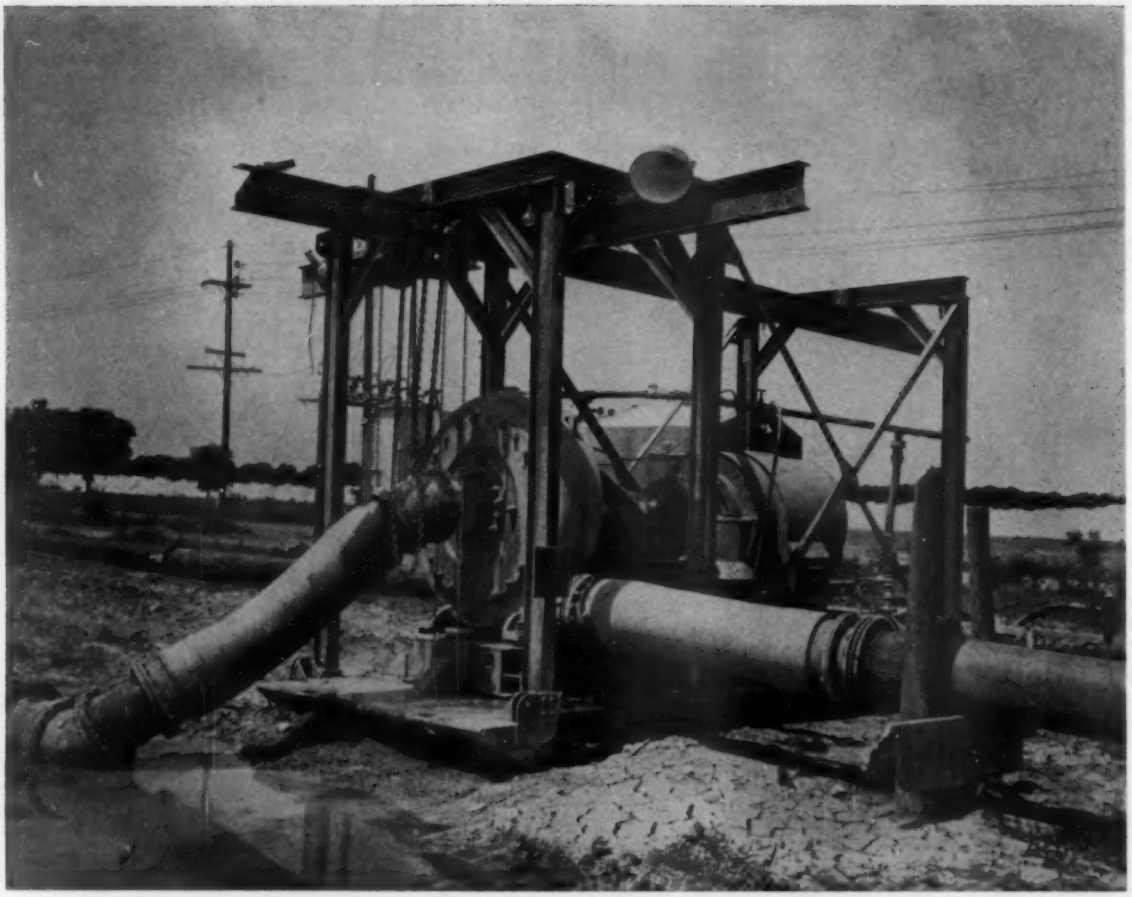
1) Pumping rate required.
2) Friction loss in pipeline and static head.
3) Type of matrix to be pumped.

The pumping rate is based on the amount of matrix to be conveyed, and the amount of feed contained per cubic yard of matrix. The static head is determined by surveys, and the friction head is calculated for the quantity of slurry to be pumped. The third factor—the type of matrix—is evaluated by personal judgment along with pumping data collected while pumping similar types of matrix.

Pipelines: The length of pipelines has varied considerably during the past year—ranging from 4000 to 25,000 ft in length. The size of pipe used is a function of the velocity believed necessary to be maintained. At present, 18-in. I.D. pipe with a ⅜-in. sidewall thickness of special steel is being used. Pipeline velocities from the standpoint of economics should be held as low as practical. For most planning, the minimum velocities used are 12 ft per sec for fine-grained matrix, and 15 ft per sec for coarse-grained matrix. The percent solids in the slurry undoubtedly has an important bearing on determining critical velocities—a more dense slurry having a tendency to keep particles in suspension and prevent settling out and choking in the pipeline. An attempt to pump at a minimum of 40 pct solids is common practice.

REMOTE CONTROL VS. AUTOMATIC CONTROL OF PUMPS

Remote Control: The pit and lift pumps are operated by remote control from the pit which is ac-



A typical lift pump installation of International Mineral & Chemical Corp.'s phosphate operation in Florida. The house containing the speed control equipment, which is operated by remote control from the pit, can be seen in the background. A 24-in. pipeline carrying high-pressure water to the pit is located immediately behind the pump, and a 2½-in. tap to draw off clear water for sealing the lift pump is shown at the right. In center and left foreground are flexible couplings employed to protect the pump from movement of the pipeline due to changes in the temperature.

tuated by a pushbutton on a portable panel. When the operator depresses the pushbutton, the pit pump is started. If the pushbutton is depressed again, the pit pump's speed is increased and, if it is held in a depressed position, the pit pump speed keeps increasing until full speed is reached. In like manner, after the pit pump is running full speed, the nearest lift pump can be brought to full speed, or any desired intermediate speed. This effect is transmitted from lift pump to lift pump down the pipe line. As each lift pump reaches full speed, the switching becomes effective on the next pump down the line. To slow down or shut down the system, a second pushbutton can be actuated which reverses the above process. All pumps can be operated at any one of five speeds.

Automatic Control: Automatic control of lift pump speeds has also been used successfully. The automatic control utilizes a mercoid pressure switch with diaphragm sensor, known in the trade as an on-and-off control with a pre-set dead band. This is a pressure switch with a single-pole double-throw switch, with a dead band in the center. With the usual setting, an increasing pressure of 40 lb will start the pump and will continue to increase the speed of the pump until either the pressure drops below 40 lb or the pump reaches full speed. When the pressure drops below 40 lb, a constant speed is maintained until the pressure reaches 40 lb again or drops to 20 lb. If the pressure drops to 20 lb, the other switch is made and the pump starts slowing down, and will continue to slow down until it stops or the pressure levels off to about 20 lb.

Advantages and Disadvantages of the Two Systems: The remote control system allows the operator positive control of the pumping system, and provides a positive means of regulating pump speeds. The principal disadvantage is that the system does not allow the load to be distributed among all the pumps in the system. With the exception of one pump, all pumps are either running at full speed or are shut down. When pumping at less than full system capacity and several pumps near the discharge end of the line are shut down, high pressures can be built up locally in the system. The remote control system has a distinct advantage in lower power consumption per ton-mile.

The automatic control of lift pump speeds allows the load to be more nearly equally distributed among all the pumps in the system. When the system is running at less than full capacity, it will adjust itself to where all pumps are running at less

than full speed. This state of equilibrium will be reached and maintained without long periods of "hunting" with its resulting opening and closing of contactors or rotation of drum controllers.

The main disadvantage encountered was the malfunction of the devices which governed pump speed changes. As refinements are made in the operation of these devices, the automatic control of lift pumps will be more successful.

Water hammer and pressure transients have contributed to pumping difficulties at both the Noralyn and Achan mines. A number of protective devices to eliminate or minimize pump and pipeline breakage from these sources have been developed and used; among them have been open stand-pipes, pressure relief valves, a desurging device developed by company employee, diaphragms calculated to rupture at pre-determined pressures, air chambers, vacuum breakers which eliminate negative pressures on the suction side of pumps, and a number of different piping schemes on the suction and discharge sides of pumps. It is extremely difficult to accurately evaluate protective devices, and widely varying opinions are reached as to the relative merits of various schemes. The most popular protective device has been the construction of very heavy pedestals on the suction and discharge side of the pumps to prevent pipeline movement from being transmitted to the pump, shaft and bearing assemblies, or pump bases. On all pump installations, flexible couplings are installed on the suction and discharge sides to reduce the stresses which could be placed on the pumps by pipeline misalignment or movement due to temperature changes.

HYDRAULIC TRANSPORTATION AT SYDNEY MINE

by U. K. CUSTRED

American Cyanamid Co. is currently pumping phosphate matrix from its Sydney mine over distances that sometimes exceed five miles. At this operation, matrix is mined with draglines and dumped into a prepared well. A portable bar grizzly is placed in the well between the pump suction and dragline dumping area, and whenever possible, matrix is drifted through the grizzly to the pump suction.

Clays in the matrix are usually very stiff, and in order to pump the desired yardage, it is sometimes necessary to "mine over the grizzly"—that is, dumping the matrix directly into the well. This is done at the calculated risk of possibly overloading or plugging the pipeline causing pump or pipeline failure, or overloading the process plant with oversized material. In addition to those risks, mining over the grizzly causes irregular pumping and thus is done only when absolutely necessary.

In an effort to pump through the grizzly and to increase pumping yardage, present plans call for spacing the bars on the grizzly on 11-in. centers instead of present 8-in. centers and to install 18-in. pump suctions to replace existing 16-in. models.

The average pumping rate is 7600 gpm at 35 pct solids or 600 to 625 cu yd of matrix per hour. Minimum liquid velocity which will maintain the matrix in motion in the pipeline is 11.9 fps. Solid materials up to 8 in. in size tend to settle in the bottom of the pipe so that the volumetric velocity is somewhat less than the liquid velocity.

When liquid velocity is less than 11.9 fps, the pipeline begins to plug slowly; on the other hand, velocities greater than the minimum velocity increase friction loss, pipe wear, and power consumption. It is, therefore, a matter of economy to operate at, or just above minimum velocity. Sixteen-inch I.D. pipe with ⅜-in. wall thickness is used in 50-ft lengths with 150-pound flanged connections. The average life of pipe used for transporting matrix is in excess of 8 million cu yd, but when removed from the matrix line, this pipe is reused in hydraulic lines.

Booster pump installations at the Sydney operation have an inspection plate (shown to left of impeller) which facilitates inspection and removal of material from impeller. In the background, a tractor turns a 400-ft. section of pipeline 120°—an operation done each time 2½ million cu yd of matrix has been pumped through it.

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The "hump" in the pipeline prevents drainage of the pipeline when pumping downhill. An air relief valve at top of hump prevents siphoning action from occurring.

Slimes (minus 150 mesh) content of the matrix as mined averages 30 to 35 pct. The non-viscous high slimes content reduces pipe friction but does not prevent settling or stratification of the material in the pipeline.

The usual practice for freeing a plugged pipeline is to introduce clear water into the pumping system and attempt to wash out the plug. If this method fails, a more expensive and laborious alternative is to shut down the pumping network, sound the pipeline to determine where the plugging occurred, remove this section of pipe and install a new one. Under optimum conditions this method involves the loss of a minimum of four hours of mining time. It is interesting to note that pipeline plugging can occur even when exercising all possible precautions in pumping matrix through the grizzly.

Pumps are spaced at 3500-ft intervals along the matrix pipeline. These are 16x40 ½ in. centrifugal pumps with three vane impellers ranging from 34-in. to 39-in. diam. Power is provided by direct drive 800 hp wound rotor motors, 4160-v a-c, with five-speed control. Maximum speed is 600 rpm. The installed horsepower is 1 hp per 4.4 ft of pipeline, and average power consumption is 1.5 kw per cu yd-mile of material pumped.

The booster pump motors, operated by interlocked remote control, requires the relay pump located at one of two relay stations along the pipeline to be operating at full speed before the nearest booster pump can be put into operation. Similarly, this effect is transmitted from booster pump to booster pump down the pipeline. To slow down or shut down the system the procedure is reversed —that is, the booster pump farthest from the relay station must be slowed down first. Should the speed of a pump be reduced below full speed, the succeeding pumps would stop automatically. Delay timing devices are employed on the pump motor controls to assure full load to the pumps before they are put into operation.

A unique feature of Cyanamid's pumping operations is that at the intake of each booster pump is an inspection plate used for periodic inspection of the interior pump parts, or for the removal of large pieces of material lodged in the pump impeller. This feature reduces inspection time and clean-out time by 50 pct.

RELAY STATIONS

Mine pumping operations at Cyanamid's property differs from other operations in the Florida phosphate field in that two relay stations are employed as intermediate points in the 5-mile pumping system. At these relay points the matrix slurry is discharged into a sump and then picked up by a suction lift pump and conveyed to the recovery plant for processing.

A relay well is approximately 30 ft in diameter and 6 to 8 ft deep. The bottom of the well is sloped to allow the material to be drifted to the suction pump. The side of the well nearest the pump is reinforced with wood to prevent washing away of the side and to prevent disturbance of pump foundation. The suction can be raised or lowered by an electric winch which is mounted on the pump car.

There are five reasons why relay stations are preferred in conjunction with pumping operations:

1) The wells provide storage facilities through which irregular pumping or surges from the pit can be leveled out to the process plant.

2) Two or more booster pumps are operated by interlocked remote control from each relay station. Instruments at the relay stations indicate the booster pumps' performance, thus permitting constant observation and control of the entire pumping network with a minimum of capital outlay and operating personnel.

3) With liquid velocity greater than volumetric velocity, relay stations provide equilibrium points for the slurry to be composited or reconstructed. This reduces possible pipeline plugging.

Relay stations provide equilibrium points for slurry to be reconstructed and assists in leveling out surges from the pit to the process plant. Entrapped air in the pipe is released here, and water added to pumping system when required. Bell suction head on the lift pump reduces entrance head loss and entrapment of air by the pump.

4) Some clays in the matrix are semi-bentonitic and swell when mixed with water. Relay stations provide a means of adding water when it is needed.

5) It is not uncommon for air to become entrapped in the matrix lines and, if a means for air release is not provided, sufficient air pressure can be created to burst pipelines or pump shells. Relay stations provide air release, thus eliminating potential costly downtime for pipeline and pump repair.

On the other hand, there are two disadvantages in using relay stations:

1) A man is required at each relay station.
2) Pumping head is lost at each relay station.

However, it is felt that the advantages far outweigh the disadvantages.

The land is generally flat or very gently sloping and readily lends itself to pumping. However difficulties are experienced in pumping matrix downhill on grades greater than 2 pct because the liquid flows away from the solids, tending to increase pipeline plugging. Also the liquid flows away from the relay pumps and causes the pumps to lose their prime.

When pumping downhill at grades greater than 2 pct, it is necessary to install humps with air relief valves at the top to prevent siphoning action or drainage of pipelines. One hump on the discharge side of each relay pump is sufficient to relieve this siphoning action. Neither moderate uphill grades nor vertical pumping creates any additional pumping problems.

HYDRAULIC TRANSPORTATION AT TENOROC MINE

by J. L. WESTER

Approximately one year ago, Smith-Douglas Co., Inc. began using and improving the constant head pumping system in handling phosphate slurry at the Tenoroc mine in Lakeland, Fla. Although new to the phosphate field, the system is actually very simple and, we believe, revolutionary. The following information is offered in explanation of the system, the pumping units in the system, and some advantages observed through the use of the system.

In the present system, employed by Smith-Douglas Co., one pit pump and three constant-head pumping units transport the slurry at an average pumping rate of 7500 gpm at 35 pct solids with a slime content of 33-35 pct (minus 150 mesh material is classified as slimes) with a minimum velocity in the pipeline of 12 to 14 fps approximately 16,000 ft. Each pumping unit consists of 10 ft diam by 20 ft high, open top, vertically mounted tank; a power car; and a pump car. Pumps used are 16x39¼-in. centrifugal type, employing 39-in. 3-vane impellers. These pumps are driven by 800-hp., 2300 volt a-c, wound rotor type 600 rpm variable speed motors. This type of motor permits the pump to be directly coupled. The most important features of these pumping units are:

1) The units are very easy to install and maintain.
2) They are readily adapted to automation.
3) Greatly reduced pump wear and reduction or elimination of pump cavitation.

The matrix slurry from each pump is delivered to the following unit by a 16-in. I. D. pipe line which continues through the vertically mounted tank to the suction of the receiving pump. An orifice in the pipe inside of the tank permits any air in the discharge from the previous pump to be discharged into the tank and not into the pump. This in turn reduces pump cavitation. This orifice in the pipe also permits the pump to be pressurized and permits any surge of material to be expelled into the tank. By

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Pumping station at Tenoroc consists of 20-ft high tank, pump car, and power car. Connection of 16-in. slurry pipeline is shown at left. Pipe (foreground) handles overflow if the pump or electrical system breaks down.

using slip ring variable speed motors, the pumps are direct-coupled and the level of material in the tank can be controlled by increasing or decreasing the speed of the motor. As the liquid level in the tank increases, the float actuates a micro-switch which in turn, increases the speed of the motor. Conversely, as the level drops, the float deactivates the electrical contacts and thereby reduces or stops the rotation of the pump. The method of electrical control may be whatever the operating company prefers.

One saving resulting from this system of pumping is a 35 pct reduction in horsepower requirements—average power requirement is 1 hp per six linear feet of pipe. Increased pump efficiency has resulted in the pumping of the matrix slurry an equal distance with a decrease of about 600 hp.

An interesting point concerning pit pump suctions is that fins or "dogs" are installed to serve two primary purposes: 1) eliminate the swirling motion to reduce air introduction into the pit pump, and thus lessen pump cavitation; and 2) prevent oversize material from entering the pump suction.

MEASUREMENT OF ROCK PRESSURE WITH A HYDRAULIC CELL

by LOUIS A. PANEK

When rock is subjected to a load it is deformed. Ordinarily this is observed in a mine as the displacement of one point with respect to another—the deflection of the roof, which may be observed as a convergence between roof and floor; or the extrusion of material from the rib, which may be observed as a decrease of the distance between the rib and the post of a timber set. The effect of excessive pressure may be a rockburst if the rock is strong, or it may be "squeezing" ground if the rock is "soft". Some desirable effects of high stress (high in relation to strength) are the caving of roof in a longwall mining operation, the caving of ore in block caving, and the decrease in mechanical energy required to break down the mineral seam in a retreating pillar—robbing operation.

In any case, whether the observable effect of rock load is desirable or undesirable, it is a displacement, and depends on the following four factors:

1) The structure—the size and shape of openings, pillars, and linings, the geologic bedding and jointing.
2) The mechanical properties of the rock—principally the strength, modulus of elasticity, and flow characteristics.
3) The load or applied stress—primary sources are the weight of superincumbent rock, which increases with depth, and unrelieved tectonic stresses; secondary sources are redistributed pressures caused by other nearby openings, especially large mined out zones (rock pressure depends partly on the rock structure created by mining).
4) Duration of load, related to the length of time the opening is exposed.

CONTROL OF ROCK DISPLACEMENT

Rock displacement can be controlled by control of these four factors. Consider now the means of exercising such control over these factors.

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Control of the structural features is obviously possible to a great extent, as such control is exercised largely by choosing the method of mining and the methods of natural and artificial support.

Rock properties vary, even within a particular mine, but they are controllable only in the limited sense that control may be exercised by choosing the beds or zones to be mined so that rocks with undesirable properties will not occupy critical positions within the rock structure created by mining.

Rock pressure is the most complex of the four factors through which ground control can be achieved because it is invisible, difficult to measure, and poorly understood. Rock pressure is controllable only to the extent that control is exercised on the rock structure created by mining.

Considering openings within a particular mine, time of exposure varies, and is readily controllable because it is easily measured and easily understood—the longer an opening stands, the greater the likelihood of failure or excessive convergence. Control is exercised by choice of an appropriate sequence of driving openings of different classes, such as haulageways and rooms, which are required to remain well-supported for different lengths of time under different conditions. Again, control is exercised through the method of mining.

All controllable factors can be controlled by proper design of the mining method. The orientation and relative positions of the mine workings and the sequence of their excavation are likely to be much more important to ground control than is the design of artificial support. This implies that the major decisions in regard to ground control are made, knowingly or not, at the time the mining method is chosen.

WHY MEASURE ROCK PRESSURE

In addition to restrictions on the several factors, *control* implies the measurement of these factors in some sense, whether only qualitatively by visual observation, or by actual quantitative determina-

tion with a measuring instrument. Rock pressure is the most difficult of these factors to measure, largely because of the interaction between the measuring device and the rock. Nevertheless, the quantitative measurement of rock pressure is desirable for the following reasons.

Quantitative measurement is superior to "go—no go". Systematic progress in developing improved ground control practices depends on effective experimentation. It is well known that the greater the precision of measurement, the fewer the experiments required to establish the validity of a particular relationship. Evaluation of steps taken to control rock pressure is rather difficult when, as is generally true today, the evaluation is based largely on the occurrence or non-occurrence of excessive rock displacement. For example, in a coal mine the method of roof support is considered "good" if the roof stays up, and "poor" if roof falls are numerous. This is a crude form of measurement analogous to a "go—no go" gage, which may be adequate to assess the acceptability of a ground control method, but which is of little help in devising an approach to a particular ground control problem; information is needed as to the magnitude of the difference between the existing rock stress and the critical value. Quantitative measurement of rock pressure can provide such information.

Measurement of pressure is preferable to measurement of displacement. As the control of rock displacement depends ultimately on controlling the pressure that creates the displacement, knowledge of the direction and magnitude of the rock pressure is likely to be much more meaningful than knowledge of the direction and magnitude of the rock displacement or deformation. However, because displacement and deformation are so easy to measure, especially qualitatively, there is a general tendency of observers in mines to infer the direction and magnitude of rock pressure from the observed direction and magnitude of rock displacement. Analysis of stress and strain in two and three dimensions reveals that such inferences can easily lead to erroneous conclusions. Experience demonstrates that in these matters, intuition is an extremely poor substitute for adequate grounding in the fundamentals of stress analysis.

Inferences can be made independent of local rock properties. As the magnitude of deformation depends on the mechanical properties of the rock as well as on the rock pressure, the variability of rock properties tends to obscure the influence of pressure on the deformation observed at different locations within the mine. For example, in mining by block caving, after observing that ground support in grizzly drifts is better in an experimental 100x100-ft block than in the 200x200-ft blocks worked heretofore, one may (falsely) conclude that ground pressure can be reduced by working a smaller block, whereas the improvement in conditions actually may be due to more favorable rock properties. Appropriate pressure measurements can lead to conclusions that are independent of the influence of local rock properties.

Decision-making is more rapid. As the magnitude of rock deformation, particularly flow and fracture, depends on the duration of loading as well as on the applied pressure, an earlier indication of the ground control situation is obtained by measurement of rock deformation. In an operating situation, this amounts to an advance warning, permitting appropriate corrective action to be initiated, perhaps by changing the sequence or rate of extraction in the affected area so as to decrease the rock pressure before it causes excessive deformation (which might otherwise lead to the crushing of supports by squeezing ground).

PROCEDURE DEVELOPED BY USBM

Pressure measurement techniques may be subdivided into two classes, (1) measurement of change in rock pressure and (2) measurement of total

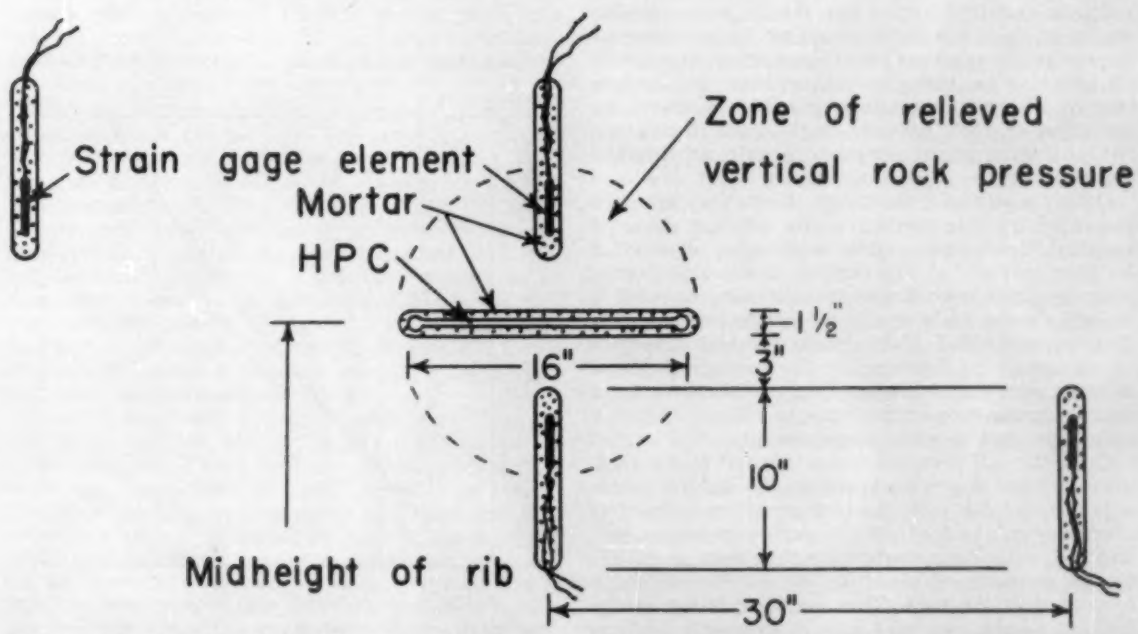


Fig. 1—Typical pressure measurement array. Vertical section through center of hydraulic pressure cell (HPC).

existing rock pressure. The latter is a more difficult and more informative measurement, because it provides simultaneously the *change* in pressure as the difference between two different measurements of *existing* pressure.

Although the U.S. Bureau of Mines has under development a pressure cell intended primarily to measure change in pressure, this paper is concerned with some apparatus and a technique developed by the Bureau to measure total existing rock pressure. The procedure is as follows: Four strain gages are cemented in vertical slots in the rib (Fig. 1), which are created by drilling a series of overlapping holes with an airleg drill. Next, a horizontal slot is created, which partly relieves the vertical rock pressure p_i within a zone roughly cylindrical in shape, centered about the slot. This causes the average initial reading G_i of the two central strain gages to change to an average value G_r, corresponding to the relieved state. (Strain gages are used in pairs to average out the influence of rock variability.) A flat steel hydraulic pressure cell (usually 12x12 in. to 16x16 in.) is then cemented in the horizontal slot and the pressure is raised within the cell until the average reading of the two central strain gages returns to the initial value G_i. When this occurs, the pressure within the cell is presumed to be equal to p_i, the vertical pressure that was formerly carried by the rock within the horizontal slot. The rock pressure is thus obtained by direct measurement rather than being determined by measuring deformation, which is then converted to pressure through a stress-strain relationship. The cycle of events is represented by the graph, Fig. 2, which was obtained from a pressure measurement array in greywacke. In this example, the central strain gages experienced an average strain relief of plus 240 microinches/in., owing to slot cutting, which was nullified when the pressure in the hydraulic pressure cell was raised to 3150 psi; hence p_i = 3150 psi. The pressure in any direction parallel to the rib surface can be determined similarly by appropriately orienting the array.

For a standard array, the strain gages are installed at the same depth in the rib as the center of the hydraulic pressure cell; hence, they respond to changes inside the rib rather than to surface changes. Within limits it is possible to study the variation of rock pressure with depth inside the rib by placing gages and pressure cells at different depths.

Other investigations show that the pressure measured by this method is the average value of existing rock pressure over a distance of about 4 in. fore and aft of the central strain gages, (the average existing rock pressure between a point 6 in. and a point 14 in. inside the rib, in the case of a strain gage located 10 in. inside the rib). There is an advantage to determining the average pressure over an area—the average is more likely to be a representative value than is the pressure at a point, unless the rock is quite homogeneous.

Once the cell pressure is made equal to the rock pressure, and the valve is closed, the fluid pressure will rise and fall with the rock pressure, remaining always equal to it, if the hydraulic pressure cell and the slot-filling mortar together possess an effective modulus of elasticity, E, not too different from that of the rock. This condition is not easily fulfilled in the case of a purely hydraulic system, which the Bureau hoped to develop. There is no easy way to determine accurately the effective E of the cell and mortar; to properly test a pressure cell in the laboratory, it would have to be embedded in a block having an area about ten times that of the cell. A testing machine capable of exerting nearly a three million-lb load would be required to create an average pressure of as much as 2000 psi in the block, with a 12x12-in. cell, the smallest cell used for field installations.

This difficulty is circumvented by using an outer pair of strain gages in the pressure measurement array (Fig. 1) to provide additional information, which makes it unnecessary to calibrate the hydraulic pressure cell, to match its modulus of elasticity to that of the rock, or even to know its modulus. The outer strain gages are installed a few feet away from the pressure cell slot so that their readings cannot be influenced by pressure relief created by the slot or pressure exerted by the hydraulic cell. When, owing to the effects of mining in the vicinity, the rock pressure changes from the initial value p_i to some new value p_n, the new rock pressure is found as (is equal to) the fluid pressure required to bring the average reading of the central strain gages to G_n rather than to G_i, because G_i corresponds to the initial rock pressure p_i. G_n is determined from the average reading of the outer strain gages at the new rock pressure p_n; it is the average reading that the central strain gages should exhibit if the pressure cell and slot were not present.

The principal objective of the investigation was to develop procedures and apparatus that are simple, reliable, and stable for long periods (at least one year) under mine conditions, so that it will be possible ultimately to make reliable pressure measurements by a routine procedure and under production conditions, with minimum time required to obtain and reduce the data. The hydraulic pressure cell and pressure control mechanism (Fig. 3) fully satisfy this requirement, as they are completely mechanical. Several versions of both were made and tested in the process of developing apparatus with the requi-

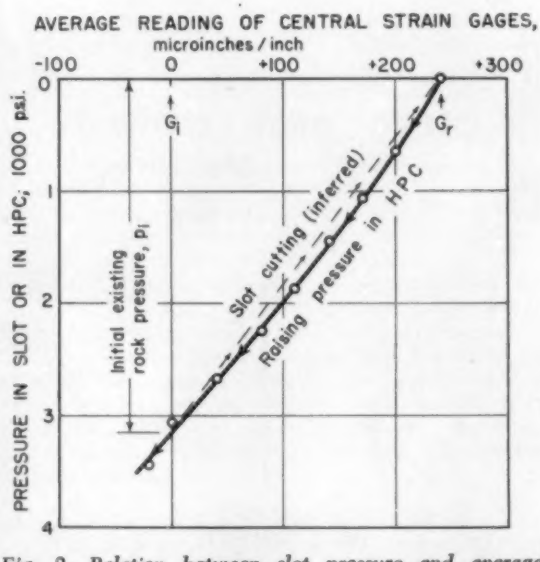


Fig. 2—Relation between slot pressure and average reading of central strain gages as the slot is drilled out and then pressured by the hydraulic pressure cell (HPC).

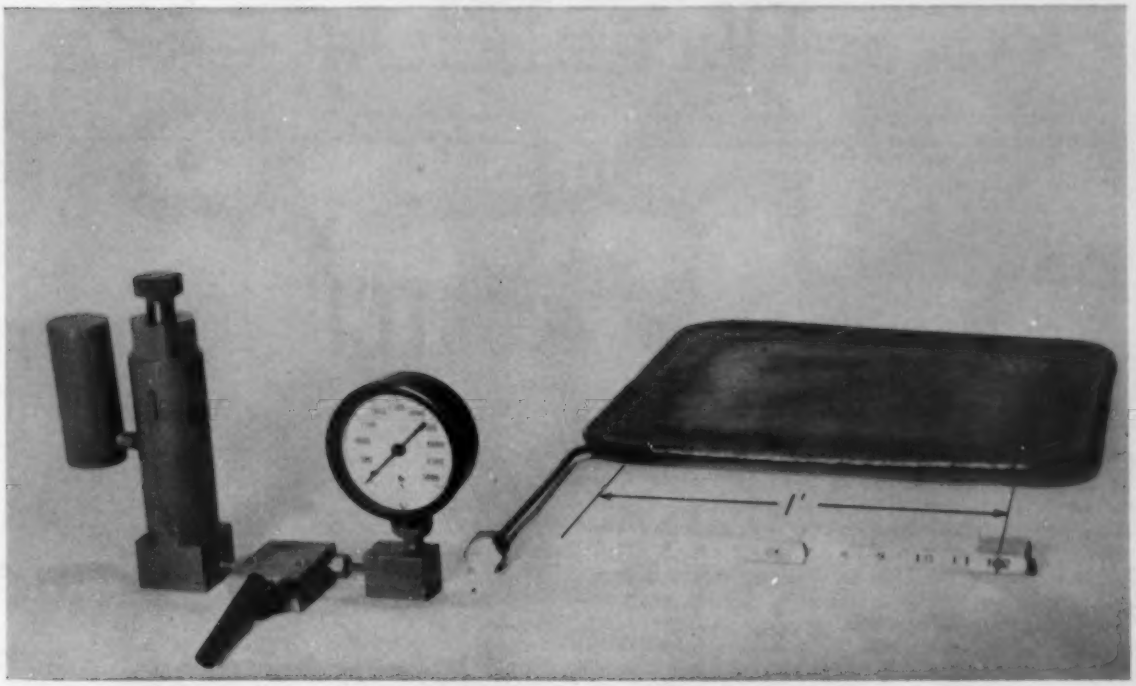


Fig. 3—Pressure control mechanism, valve, gage, and 16x16-in. hydraulic pressure cell.

site strength and convenience of operation. The maximum design pressure is 10,000 psi, which should be adequate to measure rock pressures that may be encountered at depths to at least 3000 ft. The pressure control mechanism is a combined fluid pump and fluid volume meter (for purposes other than those discussed here). It is compact, conveniently attachable, and easily operated with an ordinary hand wrench.

The strain gages were electric resistance strain gages manufactured specifically for embedment in mortar. By observing all known precautions, it has been possible to maintain the life of such gages for varying periods up to about two years; by that time, the cumulative effect of moisture usually makes their reliability doubtful.

Actually, almost any type of strain or pressure-sensitive device can perform the same function as the resistance strain gage. The choice of device depends on questions of reliability, stability, and convenience of installation and use. Recently, the laboratory has been developing a small borehole pressure cell, which, among other things, can perform this function, resulting in a pressure measurement array that is completely mechanical, requiring no electronic equipment. This will substantially improve reliability and stability and shorten the time required to install a pressure measurement array and make pressure measurements.

Experiments with a similar type of hydraulic cell were reported by E. Tincelin (International Conference About Rock Pressure and Support in the Workings, Liege, 1951, p. 160). Because the relief due to slot cutting was measured as a displacement between a pair of plugs set in the rib, the method is not well-suited to measuring pressure inside the rib. Moreover, investigations indicate that placement of the relief sensing device near the rib surface yields a rather inflated estimate of rock pressure. Also, no attention was given to measurement of pressure where changes in pressure occur after the cell is installed; a solution to this practical problem is what makes possible a more or less permanent pressure measurement station.

APPLICATIONS

The apparatus and technique described herein have been used to measure pressure in diabase, limestone, greywacke, iron ore, and concrete (drift linings) in three mines over a period of about three years. The technique appears to produce accurate results. The results are reproducible in that pressure measurements obtained from arrays in the same drift agree within the limits of experimental error, which is estimated to be about 10 pct. Also, the measured pressures are consistent with pressures that may be predicted by theory for simple stress situations. (The pressure in the rib of a rectangular opening 12 ft wide by 8 ft high, at a depth of 1500 ft, and distant from any large mined out zone, may be estimated from theoretical considerations to be about 3000 psi, allowing for the stress concentration factor and assuming a small ratio of lateral to vertical undisturbed earth pressure.)

The technique and apparatus are intended primarily to be used as semi-permanent pressure measurement stations to monitor rock pressure at locations that may be of particular interest to an investigation of certain ground control principles, or locations that may be critical to production (where failure to control rock pressure could disrupt mine production).

The USBM is collecting data from installations in three mines as part of its research on the principles of ground control. In this research, emphasis is placed on the concept of controlling rock pressure through control of the sequence of extraction, as investigators believe that this is the most fruitful approach to developing both new and better methods of mining.

TV AT TCI

Closed-circuit television was first installed underground by United States Steel's Tenessee Coal & Iron Division during the summer of 1957. Placed at a rotary dump location in one of TCI's mines, the installation was designed to permit operation of all functions of the load car haul chain, rotary dump, and empty car haul chain from a remote location, and to improve safety. The initial installation was very successful, and similar ones were subsequently placed at all of TCI's operating ore mines.

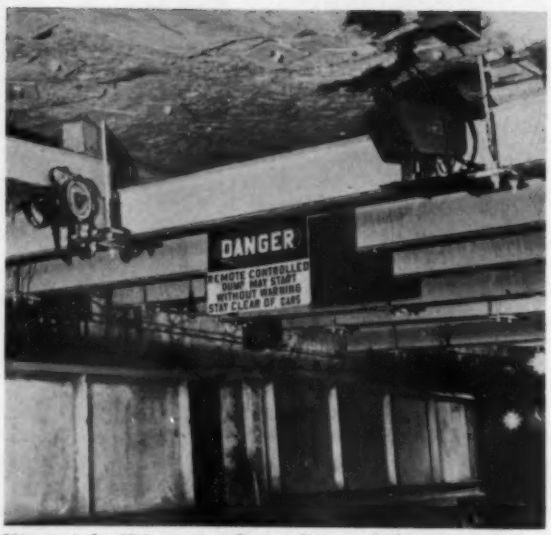
The 10-ton capacity, automatic coupled mine cars are placed on the load car haul chain by the main-line locomotives. The haulage dispatcher has been located at the skip loading point of the underground pocket, some 80 to 100 ft below the rotary dump. The video monitor is located so the operator has a constant view of the activities around the rotary dump. By means of remote controls, the TV camera can range through a four-way turret of lens changes, can pan 350° in about nine seconds, can tilt 45° up or 45° down in nine seconds, and also can range through an optical focus for any of the lens positions.

The operator has remote controls to activate the rotary dump after a car is properly positioned. Through interlocking safety controls, the rotary dump cannot be operated until 1) a specified number of loaded cars are on the car haul chain, 2) a car is properly positioned, 3) an empty has cleared the dump, and 4) a predetermined number of empties have been handled.

The TV camera and controls operate on 105-125 volt a-c. The resolution is 400 lines or better, the lens is standard 16 mm, and the range is satisfactory up to 600 ft. The light requirements with a fast lens are approximately 500 ft-candles; however, readable pictures can be obtained with less light.

Each rotary dump area is periodically whitewashed with a water and lime mixture to improve visibility. It was necessary to provide mercury-vapor lamps or a combination of mercury-vapor and incandescent lamps on about 5-ft intervals to meet the light intensity specifications. The readings at a typical installation range from 30 to 120 ft-candles.

A closed circuit or wired television provides a private system. This system has a connecting cable between the camera and monitor, thus assuring privacy that is not possible with a radiated broadcast system. This type of installation is economical where distances or obstructions are not too great. It is not necessary to obtain authorization from the Federal Communications Commission (FCC) when the wired system is utilized.



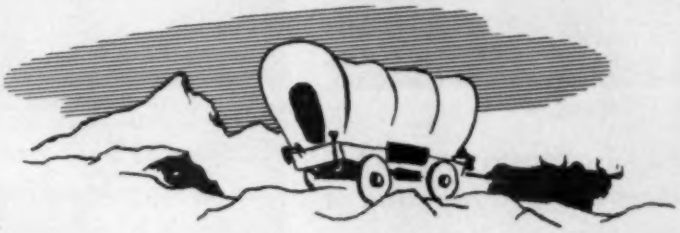
View of the TV camera directed toward the rotary dump.

Video monitor at an underground skip loading station.

The use of closed circuit television at the underground rotary dumps has resulted in improved efficiency along with improved safety. The operation of the equipment has been relatively trouble-free and maintenance costs are low.

SME BULLETIN BOARD

Reports of Your Technical Society



One Way—

Or Another

Almost Everyone Is Going To:

1. The Rock Mechanics Symposium (p. 296)
   March 30—April 1, The Pennsylvania State University
2. The International Symposium on Agglomeration (p. 297)
   April 12—14, Sheraton Hotel, Philadelphia
3. The Pacific Northwest Metals and Minerals Conference (p. 296)
   April 13—15, Davenport Hotel, Spokane
4. The Southwest Mineral Industry Conference (p. 296)
   April 24—25, Stardust Hotel, Las Vegas

SME Preprint List page 246

See Around the Sections, page 295, for a first-hand report on the petroleum industry in the USSR.

LAS VEGAS ROLLS OUT THE CARPET TO WELCOME MINERALS INDUSTRY MEN

The Southwest Mineral Industry conference, sponsored by the SME Industrial Minerals Division and the Nevada Section of AIME, will be held April 24 and 25 at the Stardust Hotel in Las Vegas, Nev. Victor Howard, of Basic Management Inc., General Chairman of the Conference, and E. Don Dilling, Titanium Metals Corp. of America, General Vice Chairman, will preside at the All Participants Session that will mark the opening of the meeting. The tentative program follows:

MONDAY, APRIL 24, AM

All Participants Session

Science and Technology in the Future: *Lewis Fussell, Jr.*, Edgerton Germeshausen & Grier Inc., Las Vegas.

Use of Abandoned Mines for Industrial Installations: A Case History: *William H. Crutchfield, Jr.*, Santa Fe Co., Los Angeles.

Enlarging Pre-Discovery Possessory Rights of Mineral Locators: *G. Henry Ladendorff*, Law Firm of Robinette & Ladendorff, Phoenix.

MONDAY NOON

All Participants Luncheon

Welcoming address: *Hon. Grant Sawyer*, Governor of Nevada

MONDAY, APRIL 24, PM

Industrial Minerals Session I

C. F. Clausen and
Fred Lohse, *Chairmen*

Limestone Resources of Southern California: *Clifton H. Gray, Jr.*, California Division of Mines, Los Angeles.

Heat Exchange and Double Cyclone Preheaters: *Ray R. Adams*, Phoenix Cement Co., Phoenix.

Permanente Cement Co. Deposit: *Edward B. Connors*, Permanente Cement Co., Permanente, Calif.

Blue Diamond Gypsum Mine: *H. L. Waldthausen, Jr.*, Blue Diamond Co. Div., Flintkote Co., Blue Diamond, Nev.

Recent Exploration for Asbestos in California: *Salem J. Rice*, California Division of Mines, San Francisco.

Extractive Metallurgy Session

R. R. Lloyd and
Karl W. Mote, *Chairmen*

Steel Manufacture in the Pacific Southwest—The Market and Raw Material Potentials: *Walter H. Voskuil*, University of Nevada.

Alumina from San Gabriel Anorthosite: *Raynard V. Lundquist*, U.S. Bureau of Mines, Boulder City, Nev.

Atlantic City Project: *S. H. Cohlmeyer, R. C. Morgan, A. S. Henderson*: Columbia-Geneva Div., U.S. Steel, Lander, Wyo.

Nuclear Session I

James L. Olsen and
D. R. McGregor, *Chairmen*

Methods of Nuclear Excavation: *Milo D. Nordyke*, University of California, Lawrence Radiation Laboratory, Livermore, Calif.

EG&G-Arms—A Future Geological

(Continued on page 290)

Pacific Northwest to be Host at April Meeting of Mining and Metal Men

Spokane will be the focal point for mining and metal men when the Pacific Northwest Metals and Minerals Conference convenes April 13-15. The meeting is being sponsored jointly by the Columbia Section of AIME and the Spokane Section of the American Society for Metals. Technical sessions will be held at the Davenport Hotel April 13 and 14. Field trips have been arranged for Saturday, April 15.

In all, eleven technical sessions have been planned—seven sponsored by AIME and four nonmetallics by ASM. AIME is planning two sessions each on mining and geology, and one each for nonmetallics, geophysics, and mineral beneficiation. One of the mining sessions is to be devoted to underground use of concrete, and papers are definitely scheduled on two topics: sinking a concrete-lined mine shaft, and concrete practice at the Sullivan mine. The other session —on sand fill—is still flexible. For

(Continued on page 304)

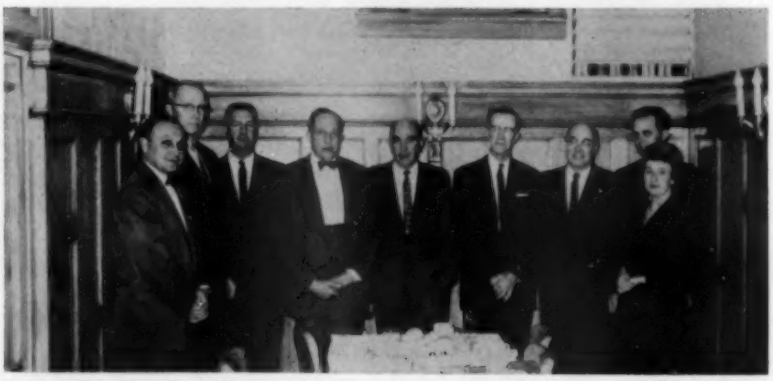
Technical Sessions Set For Spring Meeting on Rock Mechanics

The fourth Symposium on Rock Mechanics will be held on the campus of The Pennsylvania State University, University Park, Pa., March 30 through April 1. The registration desk will be open from 5:00 to 11:00 pm, March 29, at the Nittany Lion Inn. The Symposium will open with welcoming remarks by E. F. Osborn, vice president for research, The Pennsylvania State University. Five technical sessions have been scheduled as follows: Thursday morning, March 30, *Strata Movement in Underground Openings;* Thursday afternoon, *Behavior of Rock Under Static Loading;* Friday morning, March 31, *Behavior of Rock Under Dynamic Loading;* Friday afternoon, *Stress Measurement and Ground Control;* and Saturday morning, April 1, *Dynamic Loading in Rock Penetration.*

To amplify the technical sessions a blasting demonstration, model experiments, has been arranged for Friday afternoon at the close of the

(Continued on page 304)

Committee Plans for Froth Flotation Meeting



To further plans for the commemoration of the Fiftieth Anniversary of Froth Flotation in the U.S., the Executive Committee met Jan. 6, 1961, at the Oxford Hotel in Denver to discuss arrangements for the technical meeting scheduled for September 18, 19, and 20 at Denver. From left to right: W. T. Ahlborg, *arrangements;* O. W. Walvoord, *publicity;* T. H. Kuhn, *publications and translations;* E. D. Dickerman, *banquet;* R. D. Moody, *luncheons;* F. E. Briber, *general chairman;* A. L. Hill, *cocktail party;* R. L. Druva, *assistant to Mr. Briber; and* Mrs. F. L. Smith, *ladies.*

Highlights from the Northwest Mining Association Meeting

Spokane Focal Point for Mining Men

The Hotel Davenport, Spokane, provided the background for a gathering of mining men from the Northwest section of the country during the Association's meeting December 2 and 3. Caught in action, formal and informal, are some of those who attended, including many who are active in AIME affairs. Above at far left, Clark L. Wilson, member of the Emergency Lead-Zinc Committee, registers for the 66th Annual Convention. In the photo above center, Edward R. Borcherdt, mining consultant (right) talks shop with Edward D. Tierney, The Anaconda Co., between sessions. Above right, A. E. Weissenborn, 1960 chairman of the Columbia Section, AIME (right) and Warren Hobbs, USGS, admire a display set up by the Survey on the hotel balcony. To the left are pictures of one of the technical sessions and the business meeting. Shown at the far left Ross D. Leisk, vice president of the Northwest Mining Association, presents Association resolution to the floor for approval from the members. Directly to the left Angus Y. Bethune, The Bunker Hill Co., presents his paper entitled **Utilization of Zinc Metal** *to the members during one of the sessions. Mr. Bethune is 1961 chairman-elect of the Columbia Section of AIME.*

Plans Go Forward for Agglomeration Symposium

In preparation for the International Symposium on Agglomeration to be held in Philadelphia April 12 to 14, the Symposium Program Committee met in Philadelphia Nov. 1, 1960, and the Symposium Advisory Board and General Committee chairmen met November 2. Pictured above, Dwight C. Brown, as chairman of the Program Committee, summarizes the status of 69 technical papers offered for consideration by the committee. Pictured at the left the Advisory Board and General Committee Chairmen deep in a planning session. From left to right: D. C. Brown, program chairman; W. S. Cumings, finance committee; T. B. Counselman, advisory board; A. Y. Bethune, advisory board; F. M. Hamilton, advisory board; and Mrs. P. R. Hartough, secretary. Also present but not pictured were: W. F. Rappold, arrangements committee; C. F. Clausen, advisory board; W. A. Knepper, publication committee; W. B. Stephenson, general chairman; and H. N. Appleton, assistant secretary of AIME.

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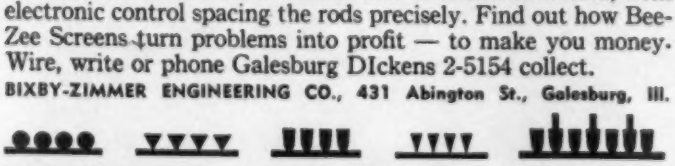

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Southwest Minerals Conference

(Continued from page 288)

Exploration Tool: *Robert B. Guillou*, Edgerton, Germeshausen & Grier Inc., Goleta, Calif.

Safety Aspects of Underground Nuclear Explosions: *Floyd W. Wilcox*, Reynolds Electrical & Engineering Co., Mercury, Nev.

An Application of Nuclear Explosives to Block Caving: *Lysle E. Shaffer*, University of California and *W. G. Flangas*, Reynolds Electrical & Engineering Co., Mercury, Nev.

Geology Session I

James R. Wilson and
Robert C. Horton, *Chairmen*

Structural Control of Cinnabar Deposition at the Cordero Mine: *Elwin L. Fisk*, Reynolds Electrical & Engineering Co. (formerly with Cordero Mining Co., McDermitt, Nev.)

Part III—The Epithermal Type of Ore Deposit from **The Application of Geology to Mining in the Southwest:** *Harrison S. Schmitt*, consulting mining geologist, Silver City, N.M.

Geological Environment of Salines in the Great Basin Area: *C. P. Keegel*, consulting engineer, Las Vegas, Nev.

Some Beryllium Occurrences in Western Utah and Vicinity: *Norman C. Williams*, University of Utah and Beryllium Resources Inc., Salt Lake City.

TUESDAY, APRIL 25, AM

Industrial Minerals Session II

R. H. Feierabend and
Lauren Wright, *Chairmen*

Industrial Minerals Development in the Central and Southern Rocky Mountains Region: *Alfred L. Ransome*, USBM, Denver.

A Summary of Industrial Minerals and Rocks in the State of Alaska: *John Y. Cole*, Kaiser Gypsum Co. Inc., Oakland, Calif.

Brucite-Magnesite Developments at Gabbs, Nev.: *Augustus M. Dixon*, Western Div., Basic Inc., Gabbs, Nev.

Geothermal Power in California: *James R. McNitt*, California Division of Mines, San Francisco.

Geology Session II

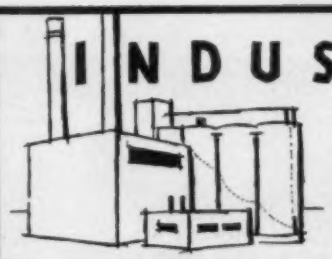
Vernon E. Scheid and
Ernest H. Clary, *Chairmen*

Seismic Survey of the Columbia River: *John F. Stickel, Jr.*, Damas & Moore, Los Angeles.

An Engineer's Concepts of Carbonatites: *Russell Wood*, Mountain Pass Mine, Molybdenum Corp. of America, Nipton, Calif.

Tectonic Relationship to Mineral Ex-

(Continued on page 304)



INDUSTRIAL MINERALS NEWSLETTER

A Word from the Editor:

Copy deadlines set by the printer for the March issue of MINING ENGINEERING make it impractical to include information on business transacted in St. Louis. Your Newsletter Editor hopes you were there and enjoyed taking part. To those who were not, we shall try to cover the pertinent news in subsequent issues.

The interesting joint meetings to be held at Las Vegas April 24 and 25 and in Ottawa October 2 and 3 deserve special attention. The Las Vegas program is in this issue. Details of the Canadian meeting and field trips will be published later. Plan to attend: it will be worth it.

Your new Industrial Minerals Newsletter Editor urgently solicits news for our monthly page. Address him at 2475 Virginia Ave., N.W., Washington 7, D.C. And—here's good luck to the 1961 officers and committees.—*Leon W. Dupuy.*

Your 1961 Division Officers

Carl F. Clausen, **1961 Division Chairman,** has been Chairman of the Cement, Lime, and Gypsum Committee; a member of the Executive Committee; and Mid-Continent Vice Chairman, 1960. Prior to joining the Portland Cement Assn., where he is director of the manufacturing process department, Mr. Clausen was assistant to the president for engineering and manufacturing, Pacific Portland Cement Co. During World War II he was chief of the Nonmetallic Building Materials Section, War Production Board; administrator of limitation orders on cement production and cement shipments; and government presiding officer on several industry advisory committees. During the Korean War he was cement industry consultant to the National Production Authority.

Leon W. Dupuy, **Secretary-Treasurer** and **Newsletter Editor,** joined the U.S. Bureau of Mines at Tucson, Ariz., in 1940 as a mining engineer, following long and varied experience in mineral industries of the Southwest, California, and Mexico. Within the Bureau of Mines, Mr. Dupuy has advanced rapidly and is presently on the staff of the director, Washington, D. C. Well known for his work on drilling and development problems, he is the author of several USBM publications and has contributed a number of articles to leading technical magazines.

Nominating Committee Chairman R. H. Feierabend, assistant vice president of Freeport Sulphur Co., needs no introduction to readers. Long active in Institute affairs, Mr. Feirabend is now beginning his second year as AIME Director-at-Large and his first year as SME Director, representing the Industrial Minerals Division. Recently he was appointed chairman of the committee to implement plans for future fall meetings of SME. As past IndMD Editor, he has been a frequent contributor to the Industrial Minerals Newsletter.

Warren R. Wagner, **Membership Chairman,** is a geological consultant with headquarters in Boise, Idaho, and also serves as geological consultant to the Industrial Chemicals Div. of Mallinckrodt Chemical Works, St. Louis. He was formerly research geologist for Colorado School of Mines Research Foundation. Mr. Wagner has a considerable background in the academic field, having taught at Idaho School of Mines, Colorado School of Mines, and Florida State University. He has also engaged in field work with USGS, USBM, Idaho Bureau of Mines and Geology, and Anaconda Copper Co.

Program Policy Committee Chairman Raphael G. Kazmann is well known in the field of hydrology. Since 1951 his private practice as a consulting ground-water engineer has taken him to many quarters of the world. He maintains headquarters in Stuttgart, Ark. From 1940 to 1945 Mr. Kazmann was active in ground-water studies sponsored by the USGS; 1945 to 1950 he served as ground-water engineer for Ranney Method Water Supplies Inc.

Donald R. Irving, **Publications Committee Chairman,** is presently with the USBM in Washington, D. C., as assistant to the chief, Division of Minerals. He entered government service in 1951 as a mining engineer for the Bureau at Spokane, Wash. The following year he transferred to the nation's capital, where he has remained. Before beginning his government career Mr. Irving held positions as ceramic engineer, research chemist, mine superintendent, mining engineer, and chemical engineer for various nonmetallic mining and processing firms in California and Nevada.

Las Vegas Joint Conference

An attractive program has been prepared by the Industrial Minerals Division for presentation at a joint meeting with the Southwest Mineral Industry Conference, to be held in Las Vegas April 24 and 25. Headquarters will be in the Stardust Hotel. (In case you didn't know—it's "on the Strip" and near many other attractions!) J. K. Brooke, our hard-working Pacific Southwest Chairman, deserves great credit for putting such an excellent program together. Needless to say, he had valiant help from our National Program Chairman, Dick Lund, and his several commodity committees. Program details are on pages 288 and 290.

C. F. CLAUSEN

L. W. DUPUY

R. H. FEIERABEND

W. R. WAGNER

R. G. KAZMANN

D. R. IRVING

ROCK IN THE BOX

Mining & Exploration Division

To All SME Readers:

Now that the New Year is well under way and two months of "Rock in the Box" have come out, it is perhaps time for the new News Editor to say hello and to ask for help.

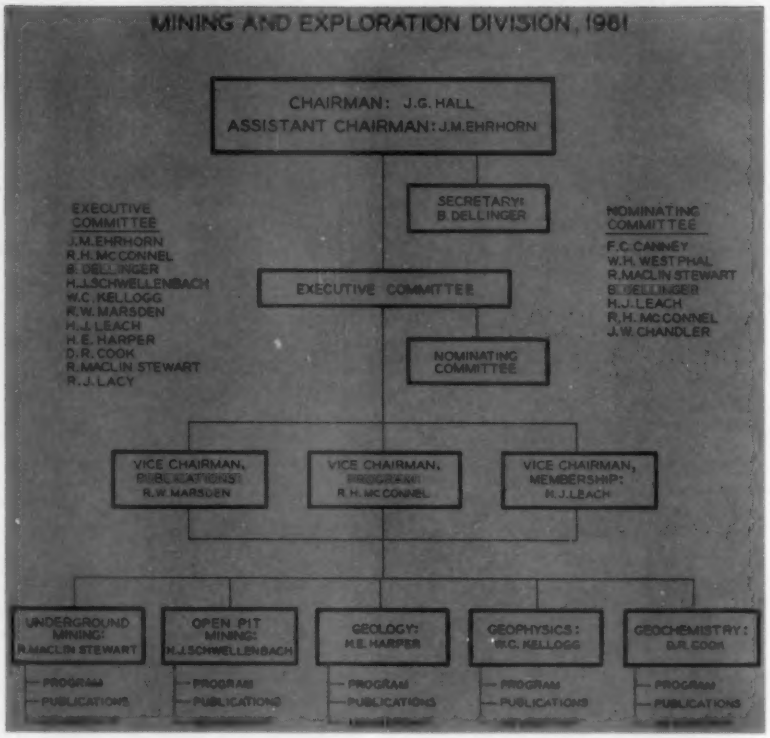
This column is for SME men. The staff of MINING ENGINEERING carries the greater part of the work load in this effort, but neither they nor I can do it alone. We will try as before to report items of news such as meetings and conferences, but we will need your help. Send us news: news of individual member's achievements, news of coming events, or even of events that have passed which might be of interest to members of the Society. All are welcome.

Finally, send us letters as to how you think the Division, the SME, or the AIME is functioning or not functioning. With your help we can make this column what you want; without your help we can only try.

Items of current interest such as meeting announcements should reach us at least six weeks in advance of the 1st of the month of the issue in which they are to appear. It takes time to put together a magazine and print it.

In the meantime, while we await your letters, we will do the best we can.—*Peter B. Nalle*, Editor

Rock in the Box
Riverside Cement Co.
P. O. Box 832
Riverside, Calif.



**The names of the committeemen selected by the five unit chairmen will be carried on the "Rock in the Box" page as soon as all appointments have been confirmed.*

National Security Seminars

PETER B. NALLE

What would you do if communication with the home office were completely cut off for a prolonged period? Or again, suppose the home office suddenly ceased to exist with all its records and controls. Who, locally, could make contracts, bill for shipments, receive money, or act for the corporation? Could or would local banks carry credit for payrolls, supplies, and equipment? Would management be capable of carrying on local divisions as autonomous units in the event of major war with the attendant destruction of large cities?

Problems such as these are discussed in a series of seminars by an earnest group of men from the Industrial College of the Armed Forces at Fort McNair, Washington, D. C. The mission of these National Security Seminars, in their words, is:

> To present a two-weeks' symposium based on the material in the ten-month course given at the Industrial College in Washington, D. C. It is given to selected reserve officers of the Army, Navy, Marine Corps, and Air Force, officers of the National Guard, and selected executives of industry and labor, and representatives of business, professions, religion, education, agriculture, women's organizations, government, and community life. . . .
>
> It seeks to foster a better understanding of the many national and international problems associated with national security, a stronger appreciation of the inseparable nature of the civilian-military team, and a clear recognition of the limitations and capabilities of each half of the team.

Some months ago your Newsletter Editor had the good fortune to attend one of these seminars. They can be highly recommended, even though some mining men might disagree with the faculty's views on mineral policy. Few mining men can completely agree even among themselves on matters of tariff and stockpiles. The faculty does give an excellent picture of the current world situation, both politically and economically.

Should the seminar be conducted in a city near you, I can recommend that you look over the program and attend at least a few of the lectures.

For the remainder of the year the schedule is:

Yakima, Wash.	March 6—17
Wichita, Kans.	April 3—14
Winston-Salem, N. C.	April 10—21
Wilmington, N. C.	May 8—19
Newark, N. J.	May 8—19

1961 UNIT COMMITTEE CHAIRMEN NAMED FOR DIVISION

Coal Division activities in 1961 will be headed by the following Unit Committee Chairmen: J. Richard Lucas—Mining, P. L. Richards—Preparation, and James R. Garvey—Utilization.

Mining Committee Chairman: J. Richard Lucas is in charge of the mining engineering division of Ohio State University, where he is engaged in teaching, research, and administration. He has held this post since 1954. During this period he has also served the mining industry in a consulting capacity, specializing in evaluation and analysis of mining properties and plants. Before his association with Ohio State University, Mr. Lucas worked as a field engineer for Joy Mfg. Co., traveling extensively around the important mining areas of the country. His first job was with Crucible Steel Corp. in the company's underground coal mining operations. A native of the southwestern Pennsylvania coal mining area, he received a B.S. in mathematics from Waynesburg College, a B.S. in mining engineering from West Virginia University, and an M.S. in mining engineering from the University of Pittsburgh.

J. RICHARD LUCAS

Preparation Committee Chairman: P. L. Richards, manager of preparation, Central Operations—Coal Div., U. S. Steel Corp., has been associated with the company since 1950 and has held his present position since 1953. From 1935 to 1950 he was with Inland Steel Corp., Raw Material — Fluorspar Div., first as a mining engineer and from 1943 to 1950 as general superintendent of the operation. Born in Champaign County, Illinois, Mr. Richards is a graduate of the University of Illinois with a B.S. in mining engineering. After graduation he was employed as an assistant geologist in the coal section of the Illinois State Geological Survey. In 1934 he went to work for Franklin County Coal Corp. as a junior mining engineer.

P. L. RICHARDS

Utilization Committee Chairman: James R. Garvey, vice president and director of research, Bituminous Coal Research Inc., has been with the company since 1946. He helped to establish the Columbus, Ohio branch in 1948, assisted in planning and operating the Columbus Coal Research activities, and was co-designer of the Columbus laboratory. Appointed assistant director of research in 1957, he was named to his present post in 1959. Mr. Garvey, a native of Pittsburgh, is a graduate of Ohio State University with a B.S. in mining engineering. Before joining Bituminous Coal Research he was associated with Pittsburgh Coal Co. His work in the development of coal-burning equipment has gained him prominence in this field.

JAMES R. GARVEY

Midwestern Coal Subsection

The new Midwestern Coal Subsection held a membership organization meeting on Jan. 19, 1961, at Ferris's Cafe, south of Johnston City, Ill. Thirty-two vitally interested coal men came out for this important session. First order of business was the election of officers. H. E. Mauck, one of the men most concerned in forming the new group, was elected chairman. Other officers are: A. G. Gossard, vice chairman; G. R. Eadie, secretary; T. L. Garwood, treasurer; H. E. Knight, program chairman; and C. H. Hodgson, membership chairman. H. C. McCollum, W. C. Campbell, G. M. Patterson, and J. P. Weir were named members-at-large.

It was decided to hold regular monthly meetings on the third Thursday of the month, and the organization as set up intends to provide interesting and instructive programs.

The evening's program included a talk by Jack Fox, Secretary, SME, who explained the historical background of AIME and discussed the organization as it is today.

Speaker of the evening was Harold W. Jackman, of the Illinois Geological Survey, who presented an illustrated paper entitled *How to Coke Illinois Coal*. Mr. Jackman has conducted tests showing that when it is blended in the right proportions with low-volatile coals to produce coke of the required characteristics, Illinois coal can be competitive with coal from other areas.

Future meetings of the newly-formed group will be reported in *Around the Sections*.

USBM Publication

RI 5648, Injecting Solid Fuels into the Smelting Zone of an Experimental Blast Furnace, 1960, gratis.—This recent publication from the U.S. Bureau of Mines is of special interest to coalmen. The object of the tests described in this booklet was to determine the maximum amount of solid fuels that could be injected into the smelting zone of the experimental blast furnace as a replacement for the coke in the stock column. The tests showed that a certain percentage of coal could be added in this manner with beneficial results. The lower percentage of both ash and sulfur in the coal injected also adds to the efficiency of the process.

COAL DIVISION
NEWS EDITOR
RAYMOND E. DAWSON
Roberts & Schaefer Co.
201 North Wells Street
Chicago 6, Ill.

Around the Sections

• The **San Francisco Section** held its annual Christmas party Dec. 14, 1960, at the Engineers' Club. The evening began with cocktails, followed by dinner and entertainment which included an accordionist, pianist, singer, dancer, and a group billed as the Harmonica Wizards.

• The annual dinner meeting of the **Colorado Section** was held at the Petroleum Club on Dec. 15, 1960. Officers for the new year were elected as follows: A. G. Hoyle, chairman; W. L. Crow, vice chairman and F. T. Davis, secretary-treasurer. Directors for the year are: T. E. Norman, T. C. Hiestand, and C. O. Frush.

Speaker of the evening, Ray Essert of IBM, gave a talk entitled *Engineer's Application of the Digital Computer*, which drew forth a number of questions in the course of the presentation.

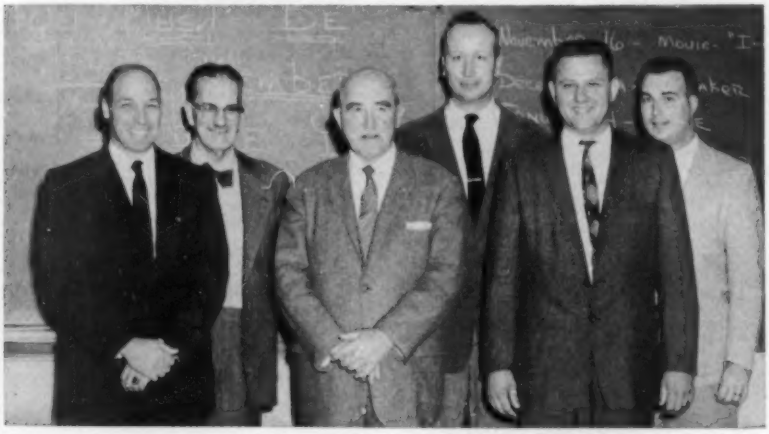
• The **Southwestern New Mexico Section** held a cocktail-dinner meeting at the Murray Hotel, Dec. 6, 1960. Twenty-five members and 28 guests attended the meeting at which AIME President-Elect Ronald R. McNaughton, Secretary Ernest Kirkendall, and Western Field Secretary Clifford J. Hicks were honored guests. Mr. McNaughton was principal speaker and Mr. Kirkendall and Mr. Hicks gave short talks.

• *Development of a New Lead Mining District* was the subject of L. W. Casteel's talk at the Jan. 13, 1961 meeting of the **St. Louis Section,** held at the Hotel York. The illustrated talk covered the development of a new Viburnum lead mining district by St. Joseph Lead Co., of which Mr. Casteel is assistant division manager. He discussed the evolution of a trackless mine and the design of a modern mill, with special emphasis on instrumentation and automation.

• The **Maricopa Subsection** (Arizona Section) met Dec. 1, 1960, at the Westward Ho Hotel in Phoenix, where they heard J. L. Neal, president, Metate Asbestos Corp., talk about mining and milling asbestos in Arizona.

• The Dec. 13, 1960 meeting of the **Morenci Subsection** (Arizona Section) was Ladies Night, with Capitol Foundry Div. of National Malleable & Steel Castings Corp. as host. All of the ladies were presented with corsages and small gifts. The meeting was held at Longfellow Inn, where members and guests enjoyed a social get-together and a steak dinner. Ted Lind of the El Paso, Texas office of Westinghouse Electric Corp. gave a short history of the corporation and spoke briefly on television programs the company has offered in the past. He also showed a light comedy film entitled *No, No, Nannette*, similar to television programs to be presented in the future. It was very well received by the audience.

Officers for 1961 were announced by Cleo Riley, chairman for membership and nominations, as follows: Joe B. Stanley, chairman; Fred M. Winkler, vice chairman and program chairman; William A. Griffith, secretary-treasurer; and Charles Sorvisto, chairman of membership and nominations.



A recent meeting of the Student Chapter of the Missouri School of Mines. Front row, left to right: R. G. Peets, assistant resident manager of Meramec Mining Co.; guest speaker E. L. Bilheimer, resident manager; and Richard O. Rouse, Student Chapter president. Back row, from left: W. C. Miller, acting chief, Rolla office, USBM; C. R. Christiansen, faculty sponsor; and Morris T. Worley, instructor,

• The **Missouri School of Mines Student Chapter** reports that among its monthly programs, which feature speakers or movies, one of the most outstanding was a talk given by E. L. Bilheimer, resident manager of Meramec Mining Co. Mr. Bilheimer spoke about the development of the vast Pea Ridge iron project near Sullivan, Mo., using slides to illustrate progress on the project since the drilling of the first test holes in the area.

• The **Carolinas Section** announced the following officers for 1961: S. Duncan Heron, chairman; Neil O. Johnson, 1st vice chairman; Ralph B. Adair, 2nd vice chairman; and Lewis J. Hash, secretary-treasurer.

The Section held an all-day meeting in Charlotte, N. C., on Jan. 20, 1961, in the Barringer Hotel. The morning program consisted of the following papers: *North Carolina Water Program* and *Quarry Unwatering Techniques* by P. M. Brown and J. O. Kimrey, USGS; *Legislation Affecting the Mining Industry* by Frank Watson, legal counselor for the North Carolina Mining Assn.; *Vibrating Ball Mills* by S. J. Beers, Industrial Minerals, Kings Creek, S. C.; and a film-illustrated talk, *Quarry Operations*, by W. G. Ross, Superior Stone Co. In the afternoon there was a visit to the Douglas Aircraft plant. The meeting ended with a cocktail hour and dinner in the Terrace Room of the hotel.

Washington D. C. Section Hears Report on Russia

Under an agreement negotiated in 1958 (recently extended through 1962) on cultural and technical exchanges between this country and Russia, the U. S. and the Soviet Union exchanged petroleum delegations last year. Alexander Gakner, then East European Specialist of the Division of Foreign Activities, U. S. Bureau of Mines (see Personals, p. 299) was one of the ten-member U. S. Petroleum Delegation to visit the Soviet Union in August. The tour of inspection was sponsored by the American Petroleum Institute.

Mr. Gakner, who formerly spent six years in the USSR, has been a student of at least one aspect of Soviet affairs—mineral economics—for the past eight and a half years. His account of this trip drew a large attendance from the **Washington, D. C. Section** on Jan. 3, 1961. Here are some notes from his report.

Traveling about Russia by plane, train, bus, car, and river boat during the entire month of August, Mr. Gakner and other members of the U.S. group covered nearly 7500 miles, inspecting oil fields, refineries, and research institutes. They inspected about one third of the Russians' refining capacity and about one tenth of their crude production capacity. "Practically from the outset of our exchanges with the USSR," Mr. Gakner reports, "the Russians attempted to take our delegations with similar interests through the same Soviet plants—usually their show pieces—over and over again. It therefore became necessary to spell out to the letter the terms of the exchange [number of people in the delegation, duration of visit, number of objectives to be visited]. And we had to tell the Russians exactly what plants and oil fields we wanted to inspect." The American delegation saw nearly all they asked for and also had meetings with the Economic Council of the Stalingrad Economic Region; GOSPLAN, the State Planning Commission; and the All-Union Petroleum Trading Organization.

Alexander Gakner (left), discusses his illustrated talk on the USSR for the January meeting with John Croston, chairman of the Washington, D. C. Section.

General view of Novo-Kuibyshe refinery—presently the largest in the USSR.

What conclusions did they draw from their visit and from reading the available literature? Mr. Gakner stresses the matter of literature, because he says: "While we found out quite a bit about individual operations, we learned practically nothing we did not already know from Soviet publications about the overall picture, the general approach, or the future plans. Many of our questions remained unanswered."

What Started the Oil Boom in the USSR? Exploration for oil involves an element of chance, but the rigid Soviet planning system leaves no room for uncertainties, and until about four years ago the Russian petroleum industry grew very slowly. "The technical people, however," writes the author, "expected that given a chance they might find a great deal of oil. So they got around the Soviet planners by classifying all step-out wells—that is, the wells aimed at outlining the reservoir after it has been discovered—as exploration wells. Hence, statistically, their exploration program is phenomenally successful. They *bring in* 5 out of 6 exploration wells. This finagling of terminology provided the Russian field men with an opportunity to do some true wildcatting, which led to the discovery of oil in Devonian formations of the Urals-Volga basin, an area which now accounts for 70 pct of the country's crude output."

Reserves: The Russians would give no specific figure but indicated that in many areas their annual rate of production is 4 to 5 pct of the measured reserve. Since production in 1959 was 130 metric tons (950 million bbl per day) Mr. Gakner estimated that the total measured reserve is between 19 and 24 billion bbl. Recently, he says, the *New York Times* credited the USSR with a proved reserve of 60 billion bbl—nearly twice that of the U. S. and about 20 pct of the world's total. On several occasions during the Americans' tour of inspection the Russians referred to their reserves as the world's largest. "True or false," writes Mr. Gakner, "they act as if they have it, and appear to shape their plans accordingly."

Refining: The Russians prefer to build plants of standard design, consisting of one line of equipment capable of refining 3 million metric tons of crude per year (about 60,000 bbl per day). Larger plants will consist of two, three, or more such lines with or without combining of the secondary processes.

Equipment: Field exploration equipment is bulky. Computers for electro-modeling of reservoirs are of the type used in the U. S. 15 or 20 years ago. But the Russians produce results and show great ingenuity in their field production equipment. They show practically none in refining equipment.

Labor: Compared with the U.S., Soviet field production crews are overstaffed by 20 to 30 pct. Their refineries employ two or three times as many people; about 45 pct are women. In research up to 50 pct are women.

Safety: There are no hard hats or safety shoes. Workers on derricks wear loosely fitting clothes. Stairs are shaky and uneven. There are low overhead pipes and protruding beams. Housekeeping is occasionally good, but generally quite poor.

From the numerous technical exchanges, Mr. Gakner concludes, it is obvious that in most industrial fields our technology is far superior to that of the USSR, but we would do well to remember that the Soviet Union has rich mineral resources and is growing in mineral and industrial strength.

Around the Sections

Continued

• The **El Paso Section** met at the Hotel Cortez on Jan. 11, 1961, where they heard Ralph S. Clayton, radiologist, give a talk called *The Problem of Surviving Nuclear Attack*. In the course of his talk, Dr. Clayton mentioned that Russia has re-equipped its armed forces twice since World War II and that during 1958 it fired some 1350 missiles. Since then it has fired only a few of them but has been mass-producing several types of guided missiles. An atomic bomb fired from a distance of one to three miles above ground would destroy everything within a circle with an eight-mile radius. The dangerous fall-out would come in about 20 min after the explosion. Properly constructed air raid shelters would save many lives.

Election of officers for the new year took place with the following results: Perry Alers, chairman; William H. Eason, vice chairman; and Guy Ingersoll, secretary-treasurer. Directors are: Paul H. Hale, J. G. Urquhart, Hallard L. Foester, Homer C. Hirsch, Warren W. Whiton, Philip Brown, and C. Handman Bush.

• The **Student Chapter of the University of Washington** reported on its activities for the fall quarter as follows: an illustrated talk on Newmont's drilling project in Alaska by Willis Beach; a talk on silver by the president of Sunshine Mining Co.; and two films—*The Forgotten Ore of Eagle Mountain* and *The Ripple Rock Blast*. Officers for the year were: Clarke Stockwell, president; Don Stevens, vice president; and Mike McCleary, secretary-treasurer.

Some University of Washington Student Chapter members. Front: Reed Miller, Mike McCleary, Clarke Stockwell. Back: Art Kimball, Dick Douglas, and Willis Beach.

• More than 80 members of the **Tucson Subsection** (Arizona Section) attended the December 14 meeting at Holiday Inn to see the movie *Target, Toquepala*. This was the largest attendance since the Subsection was formed in January 1960.

• The annual election meeting of the **Montana Section** was held Dec. 10, 1960, in the Silver Bow Ballroom of the Finlen Hotel in Butte. A social hour and fried chicken dinner preceded the main order of business—election of officers. Guy Wever was elected chairman and Lester Zeihen vice chairman. Koehler Stout was re-elected secretary-treasurer.

Notable guests at the meeting were Ronald McNaughton, AIME President-Elect; Ernest Kirkendall, National Secretary; and Clifford Hicks, Western Field Secretary, all of whom gave brief addresses. A dance followed which was enjoyed by more than 200 members, their wives and guests.

• Ladies Night of the **Chicago Section** on Jan 4, 1961, featured a talk by Peggy Stanley, manager of the Home Planning Bureau of Marshall Field & Co., entitled *Interior Design-Trends of Today*. Mrs. E. J. Bell, chairman of the local WAAIME section, served as chairman for the meeting, which was held at the Chicago Bar Assn. The occasion was a noteworthy one, for it marked the presentation of the Robert Lansing Hardy Gold Medal to Jerome B. Cohen of the department of metallurgy, Northwestern University.

Pictured at the Montana Section annual meeting from left to right are: Guy Wever, incoming chairman of the local section; AIME President-Elect Ronald McNaughton, Fred Strandberg, National Director; Ernest Kirkendall, National Secretary; and Clifford Hicks, Western Field Secretary. Other local officers: Koehler Stout, secretary-treasurer; Lester Zeihen, vice chairman; and George Hanson, outgoing chairman.

• The **Utah Section** met Dec. 15, 1960, in the University of Utah Union Bldg. for dinner and an interesting program. Joe Chambers, supervisor of applied materials and methods at the Research Div. of Marquardt Corp., presented an illustrated talk entitled *Preparation and Application of Metals in the Space Age*. The talk was followed by a film on molybdenum, showing the processing and fabrication details in preparing this metal for applications such as ramjet motors where it is subjected to extremely high temperatures.

• Richard H. Olson, assistant economic geologist of the Nevada Bureau of Mines, was guest speaker at the **Reno Subsection** (Nevada Section) meeting Dec. 9, 1960. He discussed the possible application of several of Nevada's little-known nonmetallic minerals to important uses in industrial processes. He revealed that recent research with naturally occurring zeolites indicates that they can be adapted at greatly reduced cost as substitutes for expensive synthetic compounds now used as filters in the manufacture of

high-octane gasoline, as dessicants, and as catalyst carriers in various chemical processes. The lecture was illustrated by colored slides showing source deposits and the unique method of assaying the collected samples.

• On Dec. 21, 1960, the **Lima Peru Section** heard a luncheon address by Alfonso Rizo Patron, prominent young mining and metallurgical engineer who is now chairman, as personal representative of the President of the Republic, of the Inter-Ministerial Committee on Economic Development. He is connected with several mining and industrial concerns and has recently been Minister of Development and Public Works. Mr. Rizo Patron presented ideas as to how the mining, exploration, and development of the Peruvia area could be undertaken. The Peruvia project is a large-scale irrigation-electrification program for development of the eastern slopes of the Central Andes of Peru. Basic studies for the project were recently completed by the consulting firm of Arthur D. Little Inc. In discussing the possible mining, exploration, and development phases, the speaker made a strong appeal to the mining industry for active participation. His enthusiastic presentation received warm praise from members and guests.

• The **Minnesota Section** held its annual meeting Jan. 9, 1961, at the Norshor Theater in Duluth, in conjunction with the annual mining symposium on January 10 and 11 sponsored by the University of Minnesota Extension Service. Robert J. Linney, president of Reserve Mining Co., gave the keynote address, *The Lake Superior Mining Industry: Its Problems—Its Possibilities.* Mr. Linney's opening speech was followed by a talk entitled *A Challenge to Lake Superior Ores* by M. O. Holowaty, chief engineer of Inland Steel Co. M. E. Volin, R. R. Beebe, and W. H. Hockings, all of Michigan College of Mining and Technology, discussed problems in beneficiating the oxidized iron formations.

Luncheon was held in the Hotel Duluth ballroom. The guest speaker, Harold J. Lunde, chose for his topic *The Economic Outlook for 1961 and Beyond.* R. R. McNaughton, AIME President, 1961, also said a few words. During the afternoon session the following papers were presented: *Basic Research Trends in Mining* by Paul Allsman, chief mining engineer, U. S. Bureau of Mines; *Basic Research Trends in Beneficiating* by Nathaniel Arbiter, professor of mineral engineering, Columbia University; and *Training Men for the New Iron Ore Technology* by J. S. Kopas, training counselor, Republic Steel Corp.

The dinner, also held in the Hotel Duluth ballroom, was the occasion of an award to R. J. Linney, who was

R. J. Linney, recipient of mining award.

named "Man of American Mining in 1960." He was cited for his leadership in the design and operation of taconite mining and milling facilities. In February 1960 Mr. Linney received the AIME William Lawrence Saunders Medal for distinguished achievement in the field of taconite pellet production. Guest speaker of the evening was Wyatte F. DeLoache, of E. I. du Pont de Nemours & Co., whose talk was entitled *The Menace of the Misinformed.*

The following members of the Minnesota Section were elected officers for 1961: Eugene P. Pfleider, chairman; R. C. Ferguson, Charles Grant, and John Hearding, vice chairmen; and W. F. McDermott, re-elected secretary-treasurer.

• D. H. Lyon, of Kollstan Semiconductor Elements Inc., presented an informative talk on the semiconductor industry at the Dec. 8, 1960 meeting of the **Colorado School of Mines Student Chapter.** In his talk, Mr. Lyon covered a brief history of the industry and reviewed late developments in materials and devices, with emphasis on crystal structure. After the talk the students made a tour of the Kollstan plant in Golden.

D. H. Lyon addressing the Student Chapter at the Colorado School of Mines.

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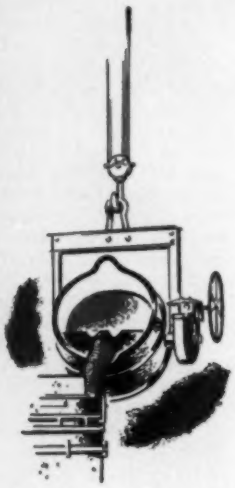

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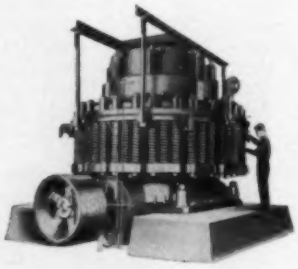

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Personals

Contrary to the Personals item in January, page 66, **James K. Richardson** was transferred from Glover Associates (Canada) Ltd. to the American organization, Glover Associates Inc., and has opened an office for the American Company at 120 Montgomery St., San Francisco. Mr. Richardson is also vice president of Glover Associates Inc.

S. E. JEROME

A. C. DAMAN, JR.

Alexander Gakner, internationally known expert on the Soviet mineral economy, has resigned from the Federal Bureau of Mines to accept the position of assistant vice president, International Div., Royer and Roger Inc. Last summer he represented the Bureau of Mines on the team of experts from the U.S. petroleum industry that inspected a large part of the Soviet oil industry.

Mr. Gakner plans to continue research activities on the mineral economies of the Soviet Bloc countries within the framework of Royer and Roger's activities, which also include technical and scientific translations, abstracts, and bibliographical work from Russian and other East European languages. His new business address is 1000 Vermont Ave., N.W., Washington 5, D.C.

The appointment of **Stanley E. Jerome** as associate director of the Nevada Bureau of Mines and the Nevada Mining Analytical Laboratory, public service agencies of the Mackay School of Mines, was announced recently by **Charles J. Armstrong,** president of the University of Nevada. Prior to his present appointment, Mr. Jerome was consulting geologist for Hunting Geophysical Services Inc., Salt Lake City.

Arthur C. Daman, Jr., recently returned to Denver from Lima, Peru, where he organized and managed Denver Equipment Co. (Peru) S.A. for the past three years. He is presently attached to the company's International Sales Div., with headquarters in Denver. He is responsible for all sales activities in Mexico, Central America, and South America.

At the beginning of the new year **E. H. Roberts** was appointed to the position of mine superintendent, with responsibility for and authority over underground operations of Inland Steel Co. coal mines at Wheelwright and Price, Ky. Since 1950 Mr. Roberts has worked with Inland Steel Co. in several capacities, including assignments as superintendent of underground maintenance and mining engineer.

Following six months spent with National Smelting Corp., Avonmouth, England, to gain experience in operating the blast furnace developed by the company to treat zinc-lead flotation concentrates, **Donald C. Vernon** returned to Australia to take the position of smelter superintendent for Sulphide Corp. Pty. Ltd. He had formerly been mill superintendent for Territory Enterprises Pty. Ltd. Both companies are subsidiaries of Consolidated Zinc Pty. Ltd.

Derek J. Barratt, a student at the Royal School of Mines, London, has interrupted his academic studies to work for McIntyre-Porcupine Mines in Ontario. He will resume his studies in the fall.

C. P. Gall, construction consultant specializing in shaft and foundation freezing, has shifted his operations from Painesville, Ohio, to San Clemente, Calif. He started his consulting practice at the beginning of 1960 when he retired from his position as project manager with Winston Bros. Co. in Minneapolis. He is now working on special assignments for Winston Bros. and other companies and is actively engaged in several freezing projects, including the Litani tunnel project for The United Engineering Co., Beirut, Lebanon.

H. B. Fyffe, area manager for Eagle-Picher Co., has been transferred from St. Louis to Houston.

David L. Veith has been transferred back to the Pickands Mather & Co. laboratory at Hibbing after spending ten months at Wabush Lake, Labrador, at the Wabush Iron Co. Ltd. pilot plant operation, where he was in charge of all sampling and sample preparation. During the summer months he also acted as shift foreman.

Southern Peru Copper Corp. recently announced three executive appointments: **Edward McL. Tittmann** was

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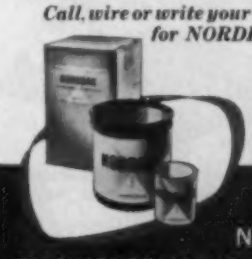

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personals

continued

named president and will also retain his chairmanship of the executive committee. He will make his headquarters in New York. **F. W. Archibald** was named vice president and general manager in charge of all of the company's operations in Peru. He will be stationed at Toquepala, Peru, site of the company's open pit copper mine, mill, and smelter. **D. J. Buckwalter** has been appointed smelter superintendent.

J. R. MILLER

R. T. McINTOSH

U. S. Borax & Chemical Corp. recently announced the appointment of **J. R. Miller** to the newly-created position of management science analyst in the company's administrative department. Mr. Miller has been with the company since 1957, when he joined the U. S. Borax 20 Mule Team Products Dept. as technical manager, product development.

Roy T. McIntosh, field service engineer with Boeing Airplane Co., has been transferred from Witchita, Kan., to Chicopee, Mass., where he is senior representative for the company in all phases of field engineering work associated with its products at 8th AF Headquarters, Westover Air Force Base.

Charles H. Moore has been appointed technical director of the Copper Products Development Assn. Inc., recently founded by six major American producers. Membership is open to all copper-producing companies in the Free World and now stands at seventeen. Mr. Moore will be responsible for the direction and management of the copper research studies which **Clyde Williams,** technical director pro tempore, established at research laboratories in this country and abroad during the Association's organizational period. These projects include engineering survey studies, a study aimed at the development of a stainless copper, and an investigation of organic and inorganic coatings for copper-bearing metals. In cooperation with the technical and marketing committees of CPDA, he will also be responsible for the establishment of additional studies designed to develop new uses and markets for copper. Before accepting this new post, Mr. Moore was executive director of research and development for P. R. Mallory & Co. of Indianapolis.

Paul L. Vandeveer has become assistant mining geologist for Western Nuclear Inc. He was formerly employed by Federal, Gas Hills, Partners at Riverton, Wyo.

O. Terichow, formerly with Allis-Chalmers Mfg. Co. as application engineer in the process machinery department, has joined the U.S. Bureau of Mines Mining Research Center in Minneapolis as supervisor, mining research engineer. In his new position Mr. Terichow is engaged in basic and applied research on drilling and comminution of ores.

Gordon H. Chambers resigned as chairman of the board of Foote Mineral Co. toward the end of last year. Although retired from active employment with the company, he continues to serve as a member of the board of directors. Mr. Chambers had been with Foote since 1928 and served as president as well as chairman of the board.

Upon completion of his work at the Graduate School of Business, Stanford University, **George W. Mitchell, Jr.,** has taken a position with Ultek Corp., an electronics firm, as assistant to the sales manager.

After eight years as general manager of Sonoma Corp., **W. Alexander Hutton** has opened an office in San Jose, Calif., to carry on a general mining and consultant practice.

John A. Abramo has joined the U.S. Atomic Energy Commission at Grand Junction, Colo., as a metallurgical engineer. He was formerly general mill foreman for The Anaconda Co.

Following his graduation from the University of Wisconsin, **W. A. Alexander, Jr.,** joined Shell Oil Co. and upon completion of his training program has been assigned to the company's Midland Div. Production Dept. as a junior exploration engineer.

Robert E. Johnson, a junior mining engineer with Inland Steel Co., has been transferred from the general office at Ishpeming, Mich., to the Menominee Range.

C. G. Harris, former mining superintendent for Asbestos Corp. Ltd. at the King-Beaver Mine in Quebec, has moved to Jamaica, B.W.I., to take a job as mine superintendent with Reynolds Jamaica Mines Ltd.

R. Hartman has taken a position as methods engineer with Denison Mines at Elliot Lake, Ont. He was formerly time study engineer for Sigma Mines Ltd.

Kanji Shiobara, chief geologist at the head office of Mitsui Mining & Smelting Co. Ltd., has accepted an invitation from Marindugue Iron Mines Agents Inc. to serve as a visiting consultant geologist in Manila.

Cyanamid de Mexico, S.A. de C. V., recently announced the appointment of **Ignacio Hinojos** as technical representative of the mining chemicals department. Working out of his headquarters in Torreon, Mexico, he will provide technical assistance to Mexican mining companies in the use of Cyanamid mining chemicals and explosives. Prior to joining Cyanamid, Mr. Hinojos was metallurgical engineer with the Fresnillo Co.

H. Jay Brown has been named supervisor of industrial relations for ore haulage, the two concentrators, and the central power station of Utah Copper Div., Kennecott Copper Corp.

After 42 years of service with Oliver Iron Mining, **Leon E. Battles,** supervisor of mining engineering for the division's Minnesota operations, retired at the end of 1960. He and Mrs. Battles have settled in Bemidji, Minn.

The Explosives Dept., Hercules Powder Co., recently announced three new appointments: **Thomas E. Brown,** who has been district manager of the Pittsburgh district since 1956, was named assistant director of sales of the Explosives Department. Succeeding him as district manager is **Robert F. Kelleher,** who has been assistant manager of the Pittsburgh district since 1959. **Robert J. Shiel,** formerly technical sales service representative of the Pittsburgh district has become assistant district manager.

R. E. Byler, *assistant to the president of Western Knapp Engineering Co., San Francisco, enplanes for the Middle East, where he will join other company representatives to confer with leaders of government and industry. Among examples of U.S. industrial development to be shown will be a film of the Kennecott Copper smelter in Arizona engineered and built by Western Knapp in 1957-58.*

U. S. Smelting Refining & Mining Co. recently announced the retirement of **N. W. Rice,** chairman of the board, and **F. S. Mulock,** president. Both will continue as members of the board of directors and of the executive committee and will serve as consultants to the company. **C. G. Rice,** presently executive vice president, has been elected to succeed Mr. Mulock as president. **J. George Gange,** presently administrative vice president, has been elected senior vice president and **J. B. Metcalfe,** presently assistant to the president, has been elected vice president.

P. H. Sevensma has been appointed geologist 1V, Sullivan Mine, Mines Div. of The Consolidated Mining & Smelting Co. at Kimberly, B. C.

Promotion of six employes of the Utah Copper Div. of Kennecott Copper Corp. was announced recently. **C. Arthur Zeldin** has been named refinery superintendent, filling the post vacated earlier by the promotion of Wayne Burt. Mr. Zeldin was formerly superintendent of refinery operations. **Dean D. Kerr** has become operations superintendent at the mine, a post left vacant by the earlier announced promotion of Ray Gough. Kerr was recently general train and shovel foreman. **John C. Larson** has moved into Zeldin's former post as superintendent of refinery operations; **T. J. Blair** has advanced to general foreman of the refining tank house from casting scheduling foreman. **Farrel L. Alsop** has moved into the casting scheduling foreman spot and **John Helm** has become general train and shovel foreman for the copper pit.

With the new year, the Geology Div. of Northern Pacific Railway Co. opened an office in the Graysher Shopping Center, Hibbing, Minn. **Layton C. Binon,** who has been mining geologist for the company's iron ore properties for the past several years, is in charge of the office, with responsibility for continuing geologic studies and related investigations on the railway's properties in this region as well as lease inspection work.

Robert W. Taber has recently been named assistant to the president of The Cleveland-Cliffs Iron Co. Mr. Taber has been with Cleveland-Cliffs since 1939 except for the war years when he served with the Army Air Force. Since joining the company, he has served successively in the ore sales, mining, and finance departments.

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personals

continued

C. C. CORNELIUS

J. HALLETT

L. P. OPPENHEIM

F. T. MATTHIAS

Paul Bailly has been appointed president of Bear Creek Mining Co., the domestic exploration subsidiary of Kennecott Copper Corp. Mr. Bailly, who will make his headquarters at the company's main office in Salt Lake City, joined Kennecott in 1952 and has been district geologist for the central district of Bear Creek Mining Co. in Minneapolis since 1957.

William J. Karwoski, a recent graduate of the University of Illinois, is doing research on the hydraulic pumping of solids as a graduate student at the Colorado School of Mines.

After a six-month vacation in England, following more than 16 years in Chile with Andes Copper Mining Co., **P. K. Aldous** has returned to South America as mill operator for Frontino Gold Mines Ltd. in Colombia.

Jack Burgess is on a six-month leave of absence from Peru Mining Co., where he was a mining engineer, to serve with the U. S. Army.

Clinton C. Cornelius was recently appointed executive vice president of Emerald Coal & Coke Co. He was formerly vice president of engineering.

The appointments of **John L. Hallett** and **Louis H. Oppenheim** as vice president of Kaiser Industries Corp. and **Franklin T. Matthias** as vice president of Henry J. Kaiser Co. were announced recently. Mr. Hallett is general manager of Kaiser Engineers International, a division of the Henry J. Kaiser Co., of which he is also vice president; Mr. Oppenheim is general manager of Kaiser Engineers and a vice president of Henry J. Kaiser Co.; and Mr. Matthias is manager of heavy construction for Kaiser Engineers. Before joining the organization in the early part of 1960 Mr. Matthias was chief engineer and director of engineering and construction for Aluminum Co. of Canada Ltd.

Following his graduation from the Royal School of Mines, London University, **J. Humphriss** has taken the post of assistant metallurgist with Mufulira Copper Mines Ltd. in Northern Rhodesia.

John Ritter has taken a position as hydraulic engineer with the U.S. Geological Survey, Water Resources Branch, in Casper, Wyo., following two years in Venezuela as a petroleum engineer with Creole Petroleum Corp.

Clifford James has been named general manager of the Ensenada gold mine of Beryllium Resources de Mexico, S.A., according to a recent announcement of Bruce Odlum, president.

Leslie C. Gates recently announced the change of his firm name from *Ferguson-Gates Engineering Co.* to *Gates Engineering Co.* with offices in Beckley and Charleston, W. Va. The firm offers a complete engineering service as consulting, civil, and mining engineers.

Edwin C. Young, formerly mill superintendent for Louis Moore G. Mining Co. in Northern Transvaal, South Africa, has joined Giant Reef Gold Mining Co. in the same capacity.

Eastern Gas & Fuel Associates recently announced the following changes of superintendents in southern West Virginia mines: **Donald B. Shupe,** formerly superintendent of Wharton No. 2 mine, has been transferred to the company's Kopperston mine; **Robert H. Freeman,** superintendent of Wharton No. 1 mine, has been transferred to the Wharton No. 2 mine; and **Wayne M. Plymale, Jr.,** formerly superintendent of the recently closed Beards Fork mine, has been transferred to Wharton No. 1.

Alain Bullet, formerly with Societé des Mines de Zellidja, Morocco, is now affiliated with Mine D'Angevillers, Moselle, France.

Upon graduation from the Royal School of Mines, London, **N. E. J. Ebsworth** has gone to Northern Rhodesia to become a trainee with Mufulira Copper Mines Ltd.

A. W. Jeffers has gone to Chile to take a position as assistant concentrator superintendent with Braden Copper Co. He was formerly chief metallurgist with Shattuck Denn Mining Corp. in Arizona.

R. W. Hillmer, formerly assistant plant engineer at the East Chicago

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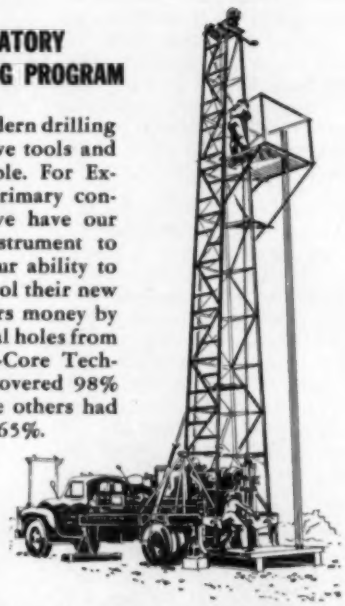

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plant of U.S. Gypsum Co., has become plant engineer at the South Gate gypsum plant of Fibreboard Paper Products Corp.

R. E. Shepard, a former explosives sales trainee for Olin Mathieson Chemical Corp., has become a mining engineer at the company's Worthy mine, Limestone Dept., in Saltville, Va.

E. L. Dana, who had been serving as district sales manager out of Duluth for the Explosives Div., E. I. du Pont de Nemours & Co., has been transferred to Pittsburgh as district sales manager for that territory.

Mine & Smelter Supply Co., Denver, recently announced the appointment of **Wade K. Halvorson** as vice president in charge of the manufacturing division. Prior to this appointment Mr. Halvorson was named director of the division.

A. J. Matthies has joined Burroughs Corp. as site engineer after receiving an M.B.A. degree from the Wharton School of Finance, University of Pennsylvania.

After 33 years with Barton Mines Corp. **H. H. Vogel** has retired to live in Florida. A vice president at the time of his retirement, Mr. Vogel will be on call as consultant.

Notice

One of the sources of news for this department is the form we send out following report of change-of-address. In a number of cases recently only the lower half of the form has been returned—without the addition of the sender's name (which appears on the upper portion of the letter)—it is impossible for us to determine whom the item concerns. Plese return the entire letter with all pertinent information correctly noted.

Paul F. Boswell, a general mine foreman for Cerro de Pasco Corp., has been transferred from Yauricocha, Peru, where he had worked for six years, to the company's mine at Casapalca.

R. H. S. Ewins has gone to Polis, Cyprus, as assistant general manager for Cyprus Sulphur & Copper Co. He had formerly been a metallurgist with Mount Isa Mines in Queensland, Australia.

R. L. Mullen, former explosives engineer for Utah Construction & Mining Co., has become foreign and domestic blasting consultant.

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CHANGING YOUR ADDRESS? Don't forget to notify us six (6) weeks before you move, if possible, to insure uninterrupted receipt of your publications and correspondence. Please fill in the form below and send it to: J. F. Lynch, Asst. Treasurer AIME, 29 West 39th Street, New York 18, N. Y.

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Old Address .....

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New Address .....

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PERSONALS: Please list below your former company and title and your new title and company (or new work) for use in MINING ENGINEERING. (Copy deadline for personals items is six weeks before date of issue.)

Former Company .....

Former Title ..... Length of Time There .....

New Company .....

New Title ..... Date of Change .....

.....

Any recent activity that would be of interest to members:

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Southwest Minerals Conference

(Continued from page 290)

ploration in Parts of California and Nevada: *W. C. McCulloch*, Southern Pacific Co., San Francisco.

Sonar Techniques for Prospecting Beneath the Ocean Bottom: *Gary Hayward, Samuel O. Raymond,* and *Harold E. Edgerton*, Edgerton, Germeshausen & Grier Inc., Boston.

Nuclear Session II

Charles E. Violet and
Larry T. Eck, *Chairmen*

The Geology and Mining Significance of Underground Nuclear Explosion, Rainier: *Thomas L. Thompson*, Stanford Research Institute.

Application of Nuclear Energy to Industry: *Leo A. Woodruff*, Atomic Energy Commission, Las Vegas, Nev.

Explosive Cratering Experiments: *Luke J. Vortman*, Sandia Corp., Albuquerque, N.M.

Radioactivities Associated with Nuclear Explosives: *Gary H. Higgins*, University of California, Lawrence Radiation Laboratory.

TUESDAY NOON

All Participants Luncheon

Speaker: AIME President *R. R. McNaughton*, The Consolidated Mining & Smelting Co., Trail, B.C.

TUESDAY, APRIL 25, PM

Industrial Minerals Session III

Frank B. Hunter and
J. K. Brooke, *Chairmen*

Grantham Mines Talc Operation: *Richard H. Franklin*, Grantham Mines, Laguna Beach, Calif.

Economic Aspects of the Interruption to Diamond Production in the Congo Republic: *A. F. Daily*, consulting mining engineer, Oakland, Calif.

Salinas of Guerrero Negro: *C. J. McClaughry*, Exportadora de Sal, S.A., Lower California, Mexico.

A Brief Survey of the Barite Deposits of California: *F. Harold Weber, Jr.*, California Division of Mines, Los Angeles.

Physical Metallurgy Session

G. A. Moudry and
John W. Riches, *Chairmen*

Properties of Electron Beam Melted Metals and Alloys: *C. d'A. Hunt*, Metallurgical Corp., Richmond, Calif.

Commercial Applications of Titanium Metal: *Leo Barron*, E. I. du Pont de Nemours & Co., Wilmington, Del.

Casting of Tungsten Base Alloys, *Russel Nardy*, Oregon Metallurgical Corp., Albany, Ore.

Improved Austenitic Manganese Steels for Abrasion-Resistant Applications: *T. E. Norman*, Abrasion-Resistant Alloy Development, Climax Molybdenum Co., Denver.

Mining Session

J. C. Kinnear, Jr., and
Frank E. Love, *Chairmen*

Underground Iron Mining in Nevada: *G. W. de La Mare*, Jackson Mountain Mining Co., Winnemucca, Nev.

Skip Haulage at Kennecott's Nevada Mines Division: *J. D. McBeth*, Kennecott Copper Corp., Ruth, Nev.

Benefits Derived from Changeover to Trackless Equipment in a Flat-Lying Ore Deposit: *Ray Schultze*, See-Tee Mining Corp., Grants, N.M.

Factors to be Considered in the Development of a Mine: *Mathew P. Rowe*, LaSalle Mining Co., Grand Junction, Colo.

Input and Output Characteristics of Electric Blasting Caps: *L. E. Sentz*, American Cyanamid Co., Latrobe, Pa.

Pacific Northwest

(Continued from page 288)

the two geology sessions the following papers are scheduled and others are pending: *Geology of the Hunters Quadrangle, Washington* and *Engineering Geologic Studies as an Aid in Urban Development.* The nonmetallic session will include papers on cement operations in the Pacific Northwest; quality concrete; precast and prestressed concrete; and cable tramway automation. The following papers have been scheduled for the geophysics session: *Magnetometer and Scintillometer Surveys in Ferry and Okanogan Counties, Washington; Aerial Magnetometer Exploration and the Attitude of the Exploration Manager* (tentative); *Seismic Survey on John Day Damsite, Columbia River, Washington and Oregon* (film with comments); and three short papers on a successive approximation method for interpreting gravity anomalies; structure calculations from gravity data and density logs; and application of gamma-gamma logs for *in situ* analysis of rocks.

ASM plans to devote two sessions each to primary metal working and secondary metal working.

New Mexico Plans for Uranium Symposium

The Central New Mexico Section is the sponsor of the Sixth Annual Uranium Symposium to be held May 12, 13, and 14 in Grants, N. M. Committees have been appointed by Clyde Osborn, Section chairman, and plans are under way for the technical program and field trip. Harve Ashby is general chairman for the Symposium and James Greenslade is assistant general chairman.

An outline of the tentative program includes a welcoming luncheon and banquet on Friday, May 12; a mining luncheon on Saturday, May 13, which will include a symposium on production grade control in uranium mining; and a milling luncheon on Saturday, May 13, which will include a forum on radiological control in uranium milling. The technical program includes a general session the afternoon of May 12; a mining and geology session the morning of May 13; and a milling session the morning of May 13. Some of the topics covered are the Ambrosia Lake District operations; mill maintenance; and the use of plastics.

Rock Mechanics

(Continued from page 288)

session and a series of informal discussion groups have been planned for that evening, following the banquet. The Symposium will close with general discussion and a summary at the end of the Saturday morning session.

A full social program has also been arranged, including an open house on Thursday evening, followed by a buffet and social evening at Centre Hills Country Club; an open house Friday morning and a banquet Friday evening in the Nittany Lion Inn main dining room, where Earl P. Strong, assistant dean, College of Business Administration, will speak.

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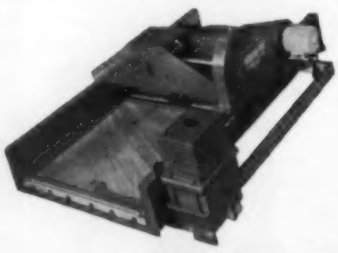

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Obituaries

Bert S. Butler

An Appreciation by

J. D. Forrester and Eldred D. Wilson

The death of Bert S. Butler (Member 1916) on Nov. 13, 1960, in Tucson, Ariz., was a great loss to the mining geology profession.

Butler was born in Gainesville, N. Y., on March 3, 1877. After graduation from Genesco State Normal School in 1889 and from Cornell University in 1905, he taught for two years in the Cornell geology department and received a Master's degree in 1907.

His love for geology and interest in mineral deposits led him into scientific work with the U.S. Geological Survey from 1907 to 1920 and from 1924 to 1927, and also into applied mining geology for Calumet & Hecla Mining Co. during 1920 to 1924. He became professor of geology at the University of Arizona in 1927, where he devoted the remainder of his professional life to teaching and research. A comprehensive review of his accomplishments in geology would fill many pages. His numerous publications include classical works on ore deposits in Utah, Michigan, Colorado, Alaska, and Arizona. He and Nels P. Peterson, of the U.S. Geological Survey, recommended in 1943 the drilling program which led to the discovery of the great San Manuel copper deposits.

Throughout a career marked by widespread acclaim for skill in gathering facts and applying a sound philosophy to their interpretation, Dr. Butler earned many distinctions. He received the honorary degree of Doctor of Science from the Colorado School of Mines in 1929. In 1947 he was awarded the Penrose Medal by The Society of Economic Geologists "for outstanding contributions to the knowledge of the geology of metallic ore deposits."

Within AIME, of which he was a member for over 44 years, Dr. Butler promoted stimulating discussions, always taking a stand for clear distinctions between facts and speculations.

At the University of Arizona, where he served as head of the geology department from 1931 to 1948, he gained renown as a remarkable educator whose lectures and field supervision inspired students to learn geology through arduous study and leg-work, to carry on detailed mapping, and to appreciate research for its scientific and economic value. Many of the

(Continued on page 306)

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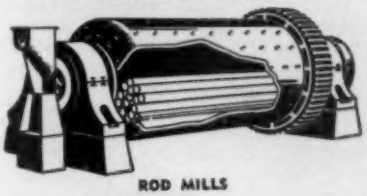
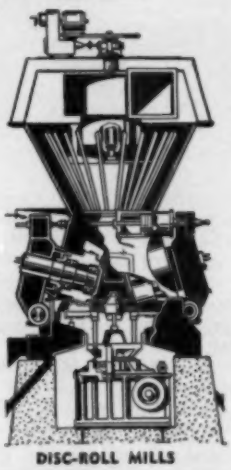
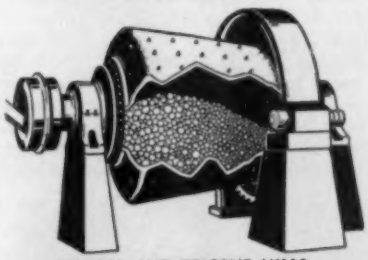


ROD MILLS



DISC-ROLL MILLS

TUBE MILLS



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Alaska.....Contact Salt Lake City Office

Obituaries

(Continued from page 305)

men trained by him have climbed high on the professional ladder.

A kind and courteous gentleman in the fullest meaning of the term, Dr. Butler was admired by all his professional associates, faculty colleagues, and students. As evidence of his continuing desire to help worthy students, he and his wife established, in 1958, a fund to support annual scholarships for graduate students in geology in the University of Arizona.

Dr. Butler ranks among the notable geologists of all time. His contributions as a scientist and teacher will continue to benefit and inspire others for many years.

Fayette E. Brown (Member 1938) died Oct. 23, 1960, at the age of 63. Born in Iron Mountain, Mich., Mr. Brown spent his life working in that area, first as assistant engineer for Mineral Mining Co. in Iron River, then as an engineer for Pickands Mather Co. in Caspian. In June 1925 he returned to Mineral Mining Co. as an engineer and the following year became assistant general manager. At the time of his death he was chairman of the board. Mr. Brown was educated at Cornell University, attending from 1915 to 1917 and from 1919 to 1921.

Claude C. Cushwa (Member 1938) died in a San Luis Obispo, Calif. hospital Nov. 1, 1960, after a brief illness. He was born March 10, 1891, in Independence, Mo., and was a graduate of the Missouri School of Mines at Rolla. The early days of his mining career took him throughout the West and Southwest as miner, millman, shift boss, timberman, and superintendent for Portland Gold Mining Co., Aurora Consolidated Gold Mining, Ray Consolidated Copper Co., Magna Copper Co., Park-Utah Consolidated Mines Co., and Silver Reef Mines Co., among others. Mr. Cushwa came to Grass Valley in 1937 to become manager of the Spring Hill gold mine. In 1952 he came to San Luis Obispo, where he was employed at the chrome mine near Morro Bay. In 1953 he went to work for the division of highways, remaining in this employment until his retirement Oct. 22, 1960.

Ray M. Henricksen (Member 1927) died recently in Fresno, Calif. He was born in Aurora, Neb., on May 6, 1900, and was a graduate of the MacKay School of Mines, University of Nevada. Prior to entering the University, Mr. Henricksen worked for five years as a miner and millman in various western gold and silver camps. Following his graduation he went to Butte, Mont., to work for Anaconda Copper Co. for a short period. From 1928 to 1930 he was director of Tonopah School of Mines in Carson City, Nev. In 1930 he moved to Fairbanks, Alaska, to take the post of associate professor of mining and ore dressing at the Alaska Agricultural College and School of Mines. In the early 1950's Mr. Henricksen became consulting engineer to Kennametal Inc., first in Fresno, Calif., and later in Fallon, Nev. He became associated with A. R. McGuire in 1959 as a consultant in geology and mining, and at the time of his death was a partner of the firm McGuire & Henricksen, with offices in Fresno.

Harry P. Hill (Member 1919), 73, died in Austin, Texas, on Oct. 6, 1960. He was a native of Austin and attended the University of Texas School of Mines. The early days of his career were spent in Mexico and Peru working for Cia. Minera de Santa Gertrudis. Northern Peru Mining & Smelting Co., and Cia. Minera Asarco. In 1929 he went to work for American Smelting & Refining Co. in Tucson and continued working for this company in various capacities in California and El Paso, Texas, until 1937, when he became a consulting engineer for C. F. Corzelius. He had been living in retirement in Austin for more than a decade before his death.

George S. McCaa (Member 1922) died Nov. 28, 1960, in Pittsburgh at the age of 76. Mr. McCaa was known as the inventor of the McCaa two-hour, self-contained breathing apparatus used in mine rescue and general fire-fighting. He was the founder of the National Mine Rescue Assn. and served the U. S. Bureau of Mines for 14 years as inspector of European mine rescue procedures. For 30 years, until his retirement in 1958, he was a mine inspector for the Pennsylvania Department of Mines. From 1935 to 1937 he served as president of the Coal Mining Institute of America. Mr. McCaa was born in Wilkes Barre, Pa., and received his E.M. degree from Lafayette College in 1910. For two years after graduation he worked for Lehigh Valley Coal Co. The next four years he spent as football coach and athletic director at two Pennsylvania colleges.

Neal M. Muir (Member 1949) died in San Francisco on Nov. 5, 1960, a few weeks before his 77th birthday. He was born in Helena, Mont., attended the University of Minnesota for one term, and then transferred to the Michigan School of Mines, graduating in 1907. The first couple of years after leaving school he spent working on railroad construction. Following that he worked for various mining companies in the West as millman, miner, assayer, foreman, and superintendent. In the 1920's and early 1930's he acted as sales

representative for several companies in Tulsa, Okla. In 1941 he went to Utah as assistant in the geological department of Utah Copper Co., and in 1942 served as production analyst for the War Production Board in Salt Lake City. From 1942 to 1947 he was with the U.S. Bureau of Mines, working as a mining engineer in Utah, Alaska, Kentucky, Missouri, Illinois, and Oklahoma. In 1947 he established a general engineering practice in San Francisco which he carried on until his death, moving his offices to Pasadena, Calif., and Grand Junction, Colo., over the years.

M. B. Nesbitt (Member 1949) died Nov. 17, 1960, in Chihuahua, Mexico, in the same state as his native Urique, where he was born Sept. 9, 1900. With his death the mining section in the area of northern Mexico lost one of its most respected members. Mr. Nesbitt was a graduate of McGill University, receiving his B.Sc. degree in mining engineering. From 1923 to 1925 he worked as engineer in charge of surveying and development work for Cusi Mining Co. and in the following two years carried on private work in prospecting and exploration. Following a year working as an engineer on the drainage project and flood control dams in the Valley of Mexico, he joined El Potosi Mining Co. as an engineer in 1928. He remained with the company until his death, attaining the position of general manager in 1957.

E. P. Scallon (Member 1936) died Nov. 19, 1960, in St. Paul at the age of 77. A native of Michigan, he was a graduate of the Michigan College of Mines. Following six months of post-graduate work at the College in 1907, he went to work for Winona Copper Co. as chief engineer. From 1909 to 1930 Mr. Scallon worked for various mining companies, mostly in the Great Lakes region, at which time he went into general consulting work and also became president and general manager of Minnesota Research Co. In 1950 he was assistant to the president, Butler Bros., and by 1953 he was serving as consulting mining engineer to M. A. Hanna Co.

Hayden F. Sears (Member 1957) died Nov. 19, 1960, in Hoyt Lakes, Minn. He was born on June 16, 1912, in Buffalo, N. Y., and was a graduate of the University of Minnesota. He worked as field engineer and timekeeper for Northern States Construction Co. on tunnel construction in St. Paul his first year out of college. In 1936 he began his association with Pickands Mather, working in various companies and mines operated by this company over the years. He became superintendent of the

(Continued on page 308)

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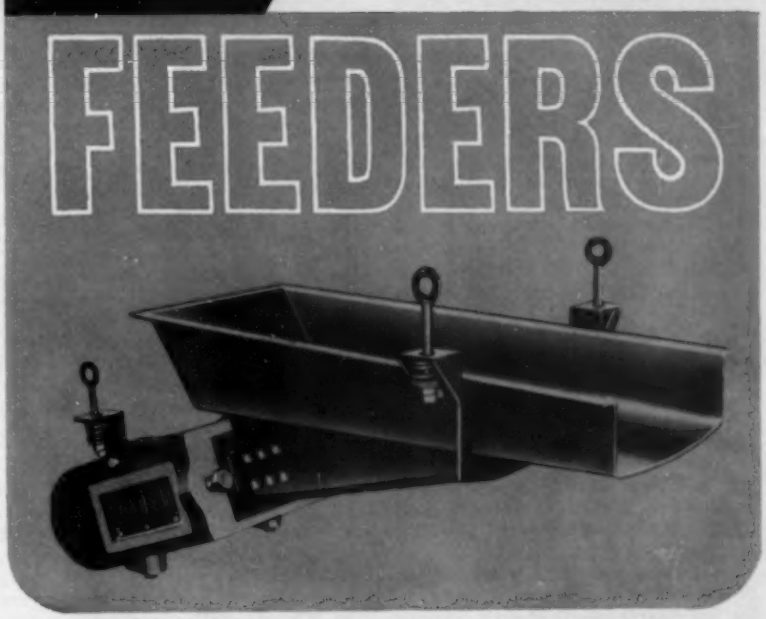

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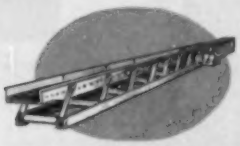


Mechanical Vibrating Conveyors

Battery Chargers

Obituaries

(Continued from page 307)

commercial taconite pit of Erie Mining Co. in 1956.

E. R. Thomas (Member 1955) former president of the First National Bank of Grand Junction, Colo., died recently at the age of 58. He was born April 2, 1902, in Hodgenville, Ky. He had been an associate member of the Plateau Section of AIME.

R. R. Wilson (Member 1917) died in Santa Barbara, Calif., Nov. 20, 1960, at the age of 70. Although a U.S. citizen, born in Carnegie, Pa., Mr. Wilson spent his professional life in Canada. He received his education at schools and colleges in the U.S., Canada, England, and South Africa. He received his degree in mining and metallurgy from Queen's University, Kingston, Ont. He was associated with and trained under W. R. Wilson, president of Crows Nest Pass Coal Co. Ltd., Fernie, B. C. Later he became resident manager of Granby Consolidated Mining, Smelting & Power Co. Ltd. As mining engineer with Trites, Wood, Wilson Syndicate he was active in developing the Premier Gold mine and as mining engineer and director of W. R. Wilson & Sons was responsible for the development of such mining properties as Windpass Gold Mining Co., the Ecstall mine, and the Hudson Hope Coal area. In later years the company operated under the name of Wilson Mining Co. Ltd. with Mr. Wilson as president. By 1953 he had moved to Santa Barbara, Calif., where he spent the last few years in professional retirement.

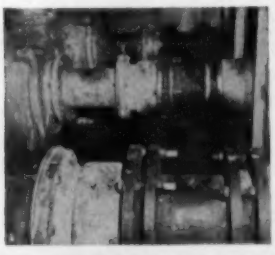
E. H. Comstock (Member 1914) died in April 1960 at Monticello, Minn. He was born in 1876 in Milwaukee and received his B.S. degree from the University of Wisconsin. The next three years he was fellow at Cornell and the University of Chicago and honorary fellow at the University of Wisconsin. From 1900 to 1906 he held various positions in the public schools of Wisconsin and Michigan. In 1906 he went to the Minnesota School of Mines as an instructor and received his M.S. degree from the University in 1907. In the same year he became an assistant professor and by 1908 was a professor in charge of courses in mine plant design.

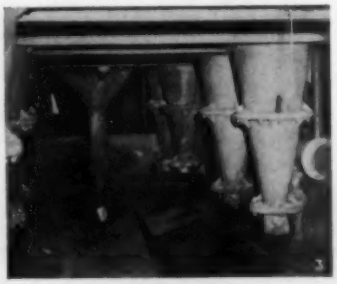
J. O. Cree (Member 1943) died June 13, 1960, in Charleston, W. Va. He was born in Centerville, Iowa, March 5, 1896, and graduated from Iowa State College in 1917. Following graduation he moved to Huntington, W. Va., where he worked as a sales engineer for Sullivan Machinery Co. After service in the U.S. Army during World War I he returned to his job with Sullivan but left after a year to take a job with West Virginia Engineering Co. in Charleston. Except for a period from 1921 to 1927, when he was associated with Virginia Iron Coal & Coke Co. and Centerville Block Coal Co., Mr. Cree made his career with West Virginia Engineering Co.

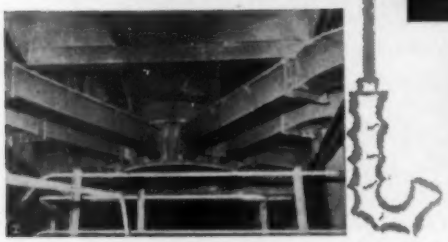
G. T. McCrorey (Member 1956) died Nov. 7, 1960, in Elvins, Mo., where he was born 56 years earlier. After attending the Missouri School of Mines, Mr. McCrorey went to work for Midwest Mining Corp. as a junior engineer. Following jobs with Missouri Ore Co. and Missouri Natural Gas Co., he joined St. Joseph Lead Co. in 1942, where he was chief surveyor.

C. T. Smith (Member 1917) died after a short illness in an Ironton, Mo. hospital on Dec. 18, 1960. Charles T. Smith was born in Glendale, Ky., and after service in the Spanish-American War spent the next 18 years in Mexico, first with the National Railways of Mexico and then the El Oro Mining Co. He was forced to leave Mexico during the Villa revolution. He returned to the U.S., and became secretary and treasurer

How to protect mining and industrial plant against abrasion and corrosion?







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2. View of Linatex-lined distribution box and chutes.
3. View of cyclone underflow and discharge hopper.

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of the Missouri Cobalt Co. at Fredericktown, Mo. He retired from this position in 1948. He was 84 years old at the date of his death.

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Total AIME membership on December 31, 1960, was 34,852; in addition 1,893 Student Members were enrolled.

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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Henry P. Flynn, Midland, Texas

Necrology

Date Elected	Name	Date of Death
1912	Benno Elkan	Jan. 6, 1961
1936	Paul E. Fitzgerald	Jan. 7, 1961
1948	R. E. Illidge	Dec. 30, 1960
1902	A. H. Jameson (Legion of Honor)	Unknown
1903	Emory T. Miller (Legion of Honor)	Dec. 26, 1960
1930	E. R. Navrocky	Dec. 5, 1960
1923	Quincy A. Shaw, Jr.	Unknown
1917	C. T. Smith	Dec. 18, 1960
1942	Harry A. Treadwell	Dec. 17, 1960
1910	John Tyssowski (Legion of Honor)	Nov. 24, 1960
1916	A. R. Walter	Oct. 13, 1960

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60F301 Oklahoma-Arkansas Coals by *B. L. Curry.*
60F302 Shaft Sinking and Lining in the Southern Illinois Coal Field by *J. W. MacDonald.*

AIME-ASME JOINT SOLID FUELS CONFERENCE, October 1960

60F400 Mechanical Mining in Low Seam Mines by *Clyde H. Storey.*
60F401 Our Knowledge of Underground Gasification in the USSR and a Comparison with US Processes by *C. D. Pears and Milton H. Fies.*

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Continued on page 312

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See pages 312 and 313

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pages 310 and 311

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Bert S. Gittins Adv., Inc.

Allis-Chalmers 248, 249
Klau-Van Pietersom-Dunlap, Inc.

American Brattice Cloth Corp. 297
Tri-State Adv. Co., Inc.

American Cyanamid Co. ..... *
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The L. W. Ramsey Adv. Agency

American Manganese Steel Div.
American Brake Shoe Co. 239
The Griswold-Eshleman Co.

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W. S. Adamson & Assoc.

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Harnischfeger Corp. 227
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Fuller & Smith & Ross, Inc.

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Foote, Cone & Belding

Humphreys Engineering Co. ..... *
Ed M. Hunter & Co.

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Beaumont, Heller & Sperling, Inc. Marsteller, Rickard, Gebhardt & Reed, Inc.

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Aubrey, Finlay, Marley, & Hodgson, Inc.

International Nickel Co., The ..... *
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Jay H. Marsh Co.

Mayo Tunnel & Mine Equipment 309
The Godfrey Agency

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Walter L. Schump, Adv.

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Ketchum, MacLeod & Groove, Inc.

Morse Bros. Machinery Co. ..... *
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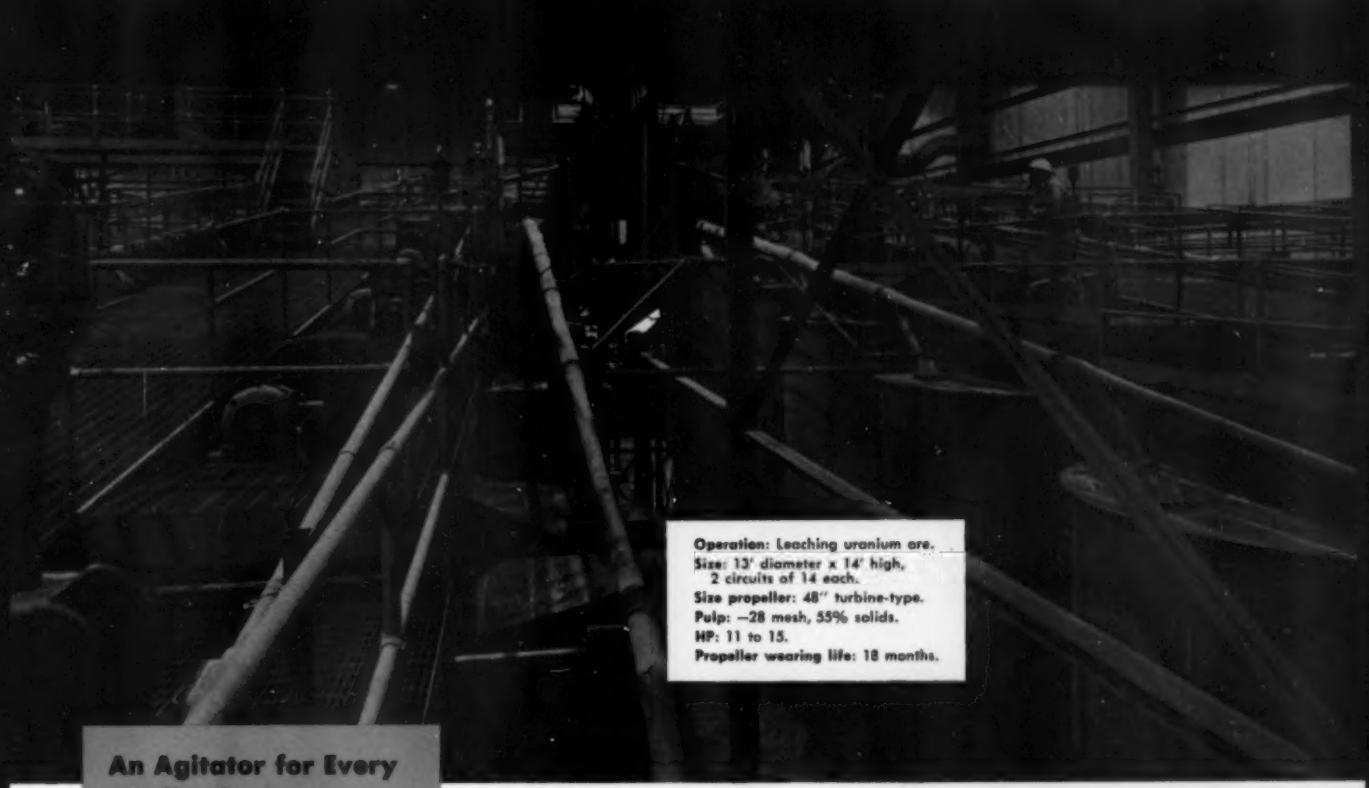

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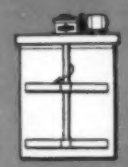

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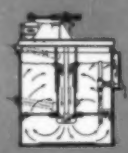

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